- Reviewed 648 water system engineering plans to provide an initial safeguard for new projects, like installing new wells, water treatment systems, well facilities, water mains, and developing wellhead protection plans.
- Launched a new version of the Mobile Sanitary Survey System software program for field use on tablet and laptop PCs.
- Enhanced consistency and improved data accuracy by launching a new internet based County Sanitary Survey System for contracted county staff who perform sanitary surveys and collect water samples at transient non-community water systems in 45 WI counties.

Region 5 wants to know when WI DNR will end the LCR consumer notification disinvestment. It was the stated reason why 35% of the new systems that became active in the last three years had active violations.

WI DNR continues to make enhancements to its sanitary survey program, which is used to develop the capacity of water systems.

#### 9. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 F083.nsf/h\_Toc/383d4a88413b802e852579c700167d85/?OpenDocument"] —WI DNR reports the number of CWSs with source water protection (SWP) plans and the number of CWSs implementing SWP measures (electronically via SDWIS, if possible) as of June 30 by August 15. WI DNR is meeting its 13% target to minimize risk at CWSs through source water protection for both CWSs and their population served. WI DNR will update source water assessments, as resources allow, especially in prioritized areas, and complete source water assessment reports for new public water systems. WI DNR recently modified its wellhead protection program to include a facilitated incentive approach for geographic target areas. WI DNR is facilitating actions with partners and stakeholders in two areas in Rock and Sauk Counties to field truth if measureable nitrate reductions in groundwater can be achieved and sustained cost effectively.

Approaches to measure groundwater nitrate reductions continue to be developed for portions of the Spring Green Prairie du Sac and Janesville well head protection areas. Local, regional and federal collaboration is occurring to develop these approaches. WI DNR BDWGW continues to make every effort to integrate relevant SDWA implementation efforts into priority setting for CWA programs.

#### 10. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 F8CA.nsf/h\_Toc/dd322cacf7ab97ca852579c7001687eb/?OpenDocument"] —There are multiple national measures in the national program manager guidance that support the "water safe to drink" subobjective 2.1.1 in EPA's strategic plan, and R5 is also tracking several other measures, including those in the logic model reporting tool, regional shared goals, and regional high priority queries. The most recent data for Wisconsin for each of these measures are available via the "measures and indicators" link, some of which have been described above in this work plan summary.

11. Resources and expertise —WI DNR maintains a baseline core of individuals with the technical expertise to carry out all mandatory components of the PWSS Program (including engineering plan and specification review and emergency response). In 2012, WI DNR had the

equivalent of nearly 73 full-time staff working with the 11,409 public water systems. Sixty-three percent of the 2012 PWSS program budget was federally funded.

Contracts with third parties conducting mandatory components of the PWSS Program will make performance expectations clear, and will be measured and evaluated by the Department. In 2012, sixteen percent of the budget went to contracts with associations, county health departments, and consultants.

WI DNR develops and implements a plan to provide adequate funding to carry out all functions of the PWSS program and has been recently successful at filling vacancies. R5 will want WI DNR to make progress in reinvesting to close acknowledged program discrepancies.

3.5 new positions will be deployed to support district offices. There is also additional management and IT support being provided to central office.

# Ohio file review and enforcement verification brainstorming meeting PROPOSED AGENDA

Tuesday, November 26, 1:00 to 2:00 p.m.

Conference room 1515B

Conference call line B: Ex. 6 Personal Privacy (PP)

Conference code: Ex. 6 Personal Privacy (PP)

The purpose of this meeting is to brainstorm ideas for how we'd like to proceed with Ohio EPA's PWSS program joint file review and enforcement verification (EV), which is planned for next summer. Here are a few proposed agenda topics—please feel free to add any others:

- 1. Update on status of review of regional protocol for conducting a PWSS program review—Jennifer
- 2. Share lessons learned from the recent MDH joint file review and EV, as well as other regional program reviews and EVs—Janet and Heather
- 3. Share thoughts about how to conduct the joint Ohio review (e.g., target certain types of systems, rules)—Everyone
  - a. For example, we can identify SDWIS, ETT, and/or logic model reporting tool (LMRT) queries that could be useful to further develop the scope of the review (e.g., which rules have the most—as well as the least—amount of violations, which rules have the longest times to RTC, etc.).
  - b. See list of attachments below with more information and questions to consider.

#### 4. Next steps

- a. Convene meetings as needed (the next one is Wednesday, December 4)
- b. Set up information-sharing system
- c. Discuss logistics when appropriate (e.g., work with Ohio EPA to set a date, request some or all files from Ohio in advance, discuss who will participate, etc.)
- d. Create project timeline
- e. Flesh out purpose of joint review and identify interview questions, define protocol and list of systems
- f. Determine report format

# LIST OF ATTACHMENTS:

- A. Scope/targeting questions (pp. 2-3)
- B. Rule- and system-specific issues to consider, etc. (pp. 3-5)
- C. Ohio EPA 2008 program review highlights (pp. 5-6)
- D. High priority query findings (p. 6)
- E. LMRT list of indicators and questions (pp. 7-8)
- F. Temporary disinvestments: Ohio EPA PWSS program discrepancies (p. 9)

### **ATTACHMENT A: SCOPE/TARGETING QUESTIONS**

# Scope:

- 1. How Ohio-specific do we want to make the joint review? Do we want to ensure the protocol easily repeatable in other states? That is, should we be keeping in mind issues other states are having—even if Ohio isn't having the same issues—so that we can repeat the same protocol in each state?
- 2. What is the purpose of the file review and EV? Do we want to modify the purposes as documented in the 2012 MDH file review and EV (see immediately below)?

The MDH file review served a number of purposes:

- a. To verify whether information in the MDH DWP databases and files is correctly represented in the federal Safe Drinking Water Information System (SDWIS/Fed), Cadmus compared MDH DWP's data to the most recently frozen data in SDWIS/Fed (i.e., the July 2, 2012 frozen database, which includes state data for the quarter ending March 31, 2012);
- b. To evaluate whether the MDH DWP is determining compliance in accordance with the National Primary Drinking Water Regulations (NPDWRs). MDH DWP's actions and policies were compared to federally mandated rules and policies;
- c. To identify specific actions that will improve MDH DWP's public water system supervision (PWSS) programs. Recommendations for MDH DWP are listed in this report that should improve their program;
- d. To determine whether MDH DWP has implemented recommendations identified in the 2007 review. EPA Region 5 asked the state to comment on the recommendations from the previous report and reviewed the answers against the current audit findings (Appendix A contains the list of recommendations and the state answers).

The purpose of the EV was to complete the following:

- a. Evaluate whether or not the Minnesota Department of Health (MDH) was following the enforcement processes outlined in available procedures and flow charts;
- b. Review enforcement documentation in MDH's files; and
- c. Compare MDH files with violation and enforcement information reported to the national Safe Drinking Water Information System (SDWIS).

# **Targeting:**

1. The following are the criteria used to create the list of systems for the 2012 MDH file review and EV:

The list of systems identified for the 2012 MDH file review were based on several factors including a focus on:

- a. CWSs;
- b. surface water systems;
- c. systems from various delegated local programs; and
- d. systems with high numbers of health-based violations.

e. The sample set was also partially based on the system's Enforcement Targeting Tool (ETT) score.

And the list of systems identified for the 2012 MDH EV was based on the following factors:

- a. Ground water and surface water transient non-community water systems;
- b. Systems formerly overseen by MDH's Environmental Health Section;
- c. Systems currently overseen by delegated local programs distributed across the state;
- d. Systems with health based violations; and
- e. Systems that had violations across all rules.

(Note: The EV evaluated the same 21 systems as evaluated in the file review, as well as 8 additional systems. Five of the 21 systems selected by HQ did not have any violations during the review period, so the EV included 24 systems.)

#### **ATTACHMENT B:** RULE- AND SYSTEM-SPECIFIC ISSUES TO CONSIDER, ETC.:

**Rules:** The following rules could be reviewed based on the reasons identified in parentheses:

- Op cert reporting to SDWIS/State (see rule completeness reporting high priority query below in attachment D)
- Nitrate reporting (see late nitrate reporting high priority query below in attachment D)
- TCR: check that PWSs are collecting at least 5 routine TCR samples in the month following a positive sample, timeliness of repeat sample collection (see yellow highlights in Ohio's 2008 program review in attachment C)
- Note: TCR and nitrate M/R: In January 2014, Ohio is beginning implementation of a new administrative penalty for failure to monitor TCR and nitrates, so it will be interesting to see if there's a decline in these violations over time.
- D/DBPs: collection and reporting of chlorine residuals (see 2008 program review, attachment C)
- GWR (because it's new, because of discrepancies identified during MDH joint review, lack of type 45 "failure to address a deficiency" reporting in some states per Heather's 11/20/13 e-mail (Ohio has reported 1 type 45 violation), and significant deficiency definition issue identified in draft primacy application)
- LCR type 66? (regional priority)

**System types:** The following system and rule-types could be reviewed:

- NCWSs and health-based standards, significant major M/R for acute health risks (regional shared goals not met)
- CWSs significant/major M/R (regional goal not met)
- Schools and day cares (regional priority)
- M/R TCR NCWSs (known issue)

Table 1 indicates the number of the various system types in Ohio.

Table 1. Ohio PWS Inventory by Source Water Type and PWS Type

Source Water / PWS Type	cws	NTNCWS	TNCWS	Total
Ground Water Under the				
Direct Influence	2			2
Ground Water	830	674	2820	4324
Purchased Ground Water	114	5	12	131
Surface Water	108	4	6	118
Purchased Surface Water	169	6	2	177
Total	1223	689	2840	4752

SOURCE: October 2013 SDWIS/Fed freeze

# Additional thoughts:

- Do we want to check inventory issues (e.g., population, NCWS lat/long, or source treatment codes, whether schools/day cares are correctly specified, etc.)?
- Do we want to find out how many systems are using electronic delivery of CCRs as part of this file review?
- Do we want to identify referral requests as part of this file review/EV?
- We should document what we won't be evaluating (e.g., we won't give a discrepancy in cases where the state didn't issue a violation when CCRs submitted to the state in July but after July 1).
- Check issue related to rads rule data errors identified through LMRT because we found out that "unregulated contaminants" have been reported to SDWIS/FED?
- Do we want to ask specific questions based on the program assessment questions (PAQs) or update information from Ohio's 2008 program review report re. waivers, data system, lab certification (e.g., follow-up questions from December 2013 audit, questions regarding capacity to analyze rads and Cryptosporidium samples), sanitary surveys, etc.?
- Identify regional issues other states are having that should be evaluated for all state file reviews and EVs in the near future (e.g., TCR hold-time requirements, LCR type 66 violations at schools and daycares)?

#### Resources to consider:

- Issues identified in 2012 MDH file review and EV that we should be checking in other states
- Other regions' file review protocols, if any exist
- Nancy Ho's analysis of state program review discrepancies
- ETT
- SDWIS/Fed
- Region 5 shared goals
- LMRT (see attachment below)
- Ohio's enforcement SOP
- Ohio now has noncompliance documents since January 1, 2007, available online via their [HYPERLINK "http://epa.ohio.gov/dir/publicrecords.aspx"] website through an eDocument Search.

Final primacy applications (not all of which have been reviewed)

#### Ohio questions and resource requests:

- Dates in summer 2013 to conduct review
- Ohio's compliance SOPs
- Ohio's system files
- Request that Ohio post the files to Quickr/SharePoint, if possible

## ATTACHMENT C: OHIO EPA 2008 PROGRAM REVIEW HIGHLIGHTS

The following are discrepancies identified in Ohio's 2008 program review, which is available on the share drive at: G:/GWDWB/Data Verification Final Reports/Ohio/2008. The yellow highlighted text indicates issues we could consider for the 2013 review.

#### TCR:

- Mentions that Ohio now requires PWSs to collect at least 5 routine TCR samples in the month following a positive sample, and has shortened the monitoring period for systems on annual or less frequent monitoring to ensure that violations are reported to EPA within 45 days of the end of the quarter (p. 10). Three discrepancies were assigned for this policy in 2008, and seven discrepancies were identified in the previous review.
- Ohio requires systems to take repeat samples within 24 hours of notification but noted that NCWSs may take up to 14 days to collect their repeat samples (p. 14).
- Stage 1: Ohio should ensure that systems calculate monthly averages and RAAs for distribution system chlorine results until SDWIS/State can be used to make the calculations (p. 11). During the 2008 review, numerous discrepancies were assigned for failure to collect or report chlorine residual samples (7), for not collecting TCR and chlorine residual samples at the same time and place (1), late submittal of results or late compliance determination or reporting (3), and failure to calculate RAAs (3) (p. 17 and Appendix C). TOC calculations were incorrect for one system, and one system collected TTHM and HAA5 samples on different days. State indicated that one of the offices does not issue NOVs for the M/R of the total chlorine residual QOR (MRDL)—the office does not have these QORs.
- **Inventory:** Inventory information was excellent, and one discrepancy was identified during the 2008 (population in state records differed from the population in SDWIS/Fed, which was an improvement from the previous review when three inventory discrepancies were identified (p. 11).
- Sanitary Surveys: program review found that 1 survey was conducted more than five years apart, and the previous review found the same thing (p. 12).
- CCRs: CCRs for five systems were received late and no violations were assigned or reported (p. 13) (however, these four systems submitted their CCRs in July, and Ohio's policy allows delivery and notification to the state up to August 15).

- Phase II/V: One system did not complete quarterly monitoring following a VOC detection. Three discrepancies were identified where invalid violations were reported to SDWIS/Fed IOCs and SOCs (p. 15 and Appendix C).
- **Rads:** There were no rads discrepancies identified (p. 18).
- LCR: During the 2008 review, one violation was reported to SDWIS/Fed with an incorrect date, and a few 90th percentile values were reported twice to SDWIS/Fed, once in the wrong units of measure. OHEPA notes that the double reporting and incorrect units is a data migration issue deriving from the old database system, and the errors will be examined and fixed (p. 18).
- **SWTRs:** During the 2004 review, one discrepancy was assigned where a treatment technique (TT) violation was reported to SDWIS/Fed as an M/R violation, and one violation was assigned but not reported to SDWIS/Fed. During the 2008 review, no discrepancies were identified (p. 19).
- **PN:** Now that OHEPA is using SDWIS/State to help track PN, OHEPA should report PN violations when systems fail to provide PN (p. 20).

#### **ATTACHMENT D: HIGH PRIORITY QUERY FINDINGS**

The following issues were identified based on the regional high priority queries (October 2013 freeze), which may be useful to evaluate in the 2013 file review/EV:

- LATE NITRATE REPORTING: As of October 2013, the CY2011 to CY2012 data indicate a decline in the timeliness of reporting between CY2011 and CY2012—96.5% of nitrate violations were reported on time in 2011 and 3.5% were reported one quarter late (2011 total: 115). In 2012, 85.2% of nitrate violations were reported on time, and 14.8% were reported one quarter late (2012 total: 88). NOTE: I'm not sure why the number of violations decreased between April and October.
- RULE COMPLETENESS REPORTING: Ohio isn't reporting Stage 1 type 12 operator certification TT violations—a system that disinfects but does not having a certified operator—so as part of the file review/enforcement verification, we should figure out what's being reported to SDWIS/State that we don't see in SDWIS/Fed.

# **ATTACHMENT E:** LIST OF LMRT INDICATORS AND QUESTIONS

The following is the list of the indicators available in the logic model reporting tool. Some data in the July 2013 dataset have been analyzed, including indicator A6(1), O6(1), and O6(1b). See yellow highlighted questions. QUESTION: Do we want to delve into any of these indicators further for purposes of targeting the scope of the review?

A6(1)—Number and percent of violations by PN tier, per year

• The following table answers the question: which rules had the least and most amount of violations in Ohio in CY2012?

Table 2. Number of Ohio EPA violations per rule and PN tier in CY 2012

		Pi	N Tier	
RuleName	1	2	3	Grand Total
SWTR		4	1	5
LT2_ESWTR		3	3	6
PN_rule			7	7
I_LT1_ESWTR	8		2	10
Arsenic		15	18	33
Other_IOC			34	34
CCR			94	94
GWR			98	98
LCR		12	96	108
Nitrates	8		100	108
St1_DBP		65	72	137
VOC			546	546
TCR	24	368	842	1234

Source: July 2013 LMRT A6(1)

O6(1)—Cumulative number and percent of chem/rad/DBP violations responded to, per year

As of 2012, there were 65 non-health-based (M/R) chem/rad/DBP violations with violation years from 2008 to 2011 with no response reported, the majority of which occurred at small and very small systems. As of July 26, 2013, no action had been taken by Ohio EPA as of July 26, 2013.

#### LCR

- 4 Type 52 violations (follow-up and routine LCR tap sampling) at 4 systems
   Nitrates
- 3 Type 3 violations (monitoring, regular) at 5 systems
   SOC
- 13 Type 3 violations (monitoring, regular) at 5 systems
   Other IOC
- 3 Type 3 violations (monitoring, regular) at 3 systems

#### VOC

- 42 Type 3 violations (monitoring, regular) at 2 systems
- O6(1b)—Cumulative number and percent of TCR/SWTR/FBRR violations responded to, per year
  - As of 2012, there were 7 TCR MCL and 1 TCR M/R violations with violation years from 2007 to 2008 with no response reported, all of which occurred at very small systems.
- O6(1c)—Cumulative number and percent of "other" violations responded to, per year
- O6(2)—Violation response rate: time (in days) between proxy violation awareness date and violation response, over the most recent 5 years
- O6(2b)—Violation return to compliance (RTC) rate: time (in days) between proxy violation awareness date and RTC date, over the most recent 5 years
  - QUESTION: Should we look into which rules have the longest times to RTC using this LMRT indicator?
- S5(1)—Number and percent of systems in compliance with TT, MCL, and MRDL requirements, per year
- S5(2)—Number and percent of systems in compliance with M/R requirements, per year
- S5(4)—Number and percent of systems in compliance with "other" requirements, per year

#### **ATTACHMENT F: TEMPORARY DISINVESTMENTS**

# Ohio EPA PWSS program discrepancies

September 14, 2012

Ohio EPA acknowledges the following disinvestments from its primary responsibility to implement and enforce National Primary Drinking Water Regulations (NPDWR) during the October 2012 to September 2013 timeframe.

## 1. Sanitary surveys

Ohio EPA is not reporting sanitary survey violations at systems when the state does not conduct a sanitary survey within the federally required intervals.

#### 2. Surface water treatment rules

Ohio EPA will not commit to electronically tracking how many systems either have met or are meeting the requirement that systems notify the state in writing within 45 days that IESWTR deficiencies identified in the sanitary surveys are corrected.

# 3. Public Notification (PN) Rule

Ohio EPA reports federal Tier 1 PN violations. Ohio EPA does track the request for PN and when the PN is received for Tier 2 and 3 violations, but does not report these PN violations. Ohio is working with the district offices to ensure consistent implementation of Tier 1 PN violations. Ohio will not expand the PN violation program until full implementation of the Tier 1 program is complete.

#### 4. Consumer Confidence Rule

Ohio does not conduct content reviews of CCRs.

# WI PWSS Indicators and Measures October 1, 2011 through September 30, 2013 (Last Updated 2/3/14)

NOTE: To access the Quickr links in the "File" column, place cursor over the link and hold down the "Ctrl" key while clicking the left mouse button.

Ħ	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
Office of	Water National Program Meas	ures					
1	% of pop. served by CWS that receive DW that meet health based standards	NPM/ GPRA	PWSS overall	SDW-2.1.1 (Updated quarterly by HQ— NPM Measures Tables filtered for active, non-RTC'd MCL violations)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1006 DC831.nsf/h_ Toc/83D9FCA BDFCC34B58 52579E10070 F70E/?OpenD	FY10: 93% FY11: 91% FY12: 91% FY13: 94%	FY10: 93.9% FY11: 93.5% FY12: 93.0% FY13: 95.4%
2	% of CWS that meet health based standards	NPM/ GPRA	PWSS overall	SDW-SP1.N11 (Updated quarterly by HQ— NPM Measures Tables)	ocument" ]  Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1006 DC831.nsf/h_ Toc/83D9FCA BDFCC34B58 52579E10070 F70E/?OpenD ocument" ]	FY10: 90% FY11: 91% FY12: 91% FY13: 93%	FY10: 93.0% FY11: 92.2% FY12: 92.5% FY13: 93.6%

#	Description	Type	Used	Name	File	Target	Results
"	Description .	.,,,-	For	Update Schedule	1.112	iniber	Related EOY Comments
3	% of "person months" in	NPM/	PWSS	SDW-SP2	Quickr: [	FY10: 96%	FY10: 96.1%
	which CWS are meeting	GPRA	overall	(Updated	HYPERLINK	FY11: 94%	FY11: 96.7%
	health-based standards			quarterly by HQ—	"https://epaq	FY12: 96%	FY12: 96.6%
				NPM Measures	px.rtp.epa.go	FY13: 96%	FY13: 96.5%
				Tables)	v/QuickPlace		
					/region5state		
					pwssprogram		
					s/PageLibrary		
					852579E1006		
					DC831.nsf/h_		
					Toc/83D9FCA		
					BDFCC34B58		
					52579E10070		
					F70E/?OpenD		
_					ocument" ]		
4	% of CWS with minimized	NPM/	PWSS	SDW-SP4a	Quickr: [	FY10: 13%	FY10: 13.2%
	risk b/c of SWP	GPRA	GW	(Updated	HYPERLINK	FY11: 13%	FY11: 13.4%
			SWP	annually in	"https://epaq	FY12: 13%	FY12: 14.5%
				October by	px.rtp.epa.go	FY13: 13%	FY13: 15%
				States)	v/QuickPlace		
					/region5state pwssprogram		
					s/PageLibrary		
					852579E1006		
					DC831.nsf/h_		
					Toc/416FBD4		
					32229E39C85		
					2579E100716		
					60A/?OpenD		
					ocument&For		
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					-		
5	% of population served by	NPM/	PWSS	SDW-SP4b	Quickr: [	FY11:	FY11:
	CWSs with minimized risk	GPRA	GW		HYPERLINK	FY12: 13%	FY12: 14.8%

b/c of SWP SWP "https://epaq FY13: 14% FY13: 16%	ited EOY Comments
	itea LOT Comments
px.rtp.epa.go	
v/QuickPlace	
/region5state	
pwssprogram	
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852579E1006	
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32229E39C85	
2579E100716	
60A/?OpenD	
ocument&For	
m=h_PageUI"	
6 % of CWS with san. survey NPM/ PWSS SDW-01a Quickr: [ FY10: 96.4% FY10: 100%	
w/i the past 3 yrs for Subpart   GPRA   SS   (Updated   HYPERLINK   FY11: 98%   2010 Comm	ent - When WDNR
H systems annually in July by "https://epaq FY12: 96% submitted the	heir application for IESWTR
HQ – Status px.rtp.epa.go FY13: 87% primacy, the	ey agreed to conduct
queries updated v/QuickPlace annual inspe	ections and full sanitary
by Region 5 in /region5state surveys onc	e every 5 years. We agreed
April and pwssprogram that this cor	mbination of annual
October) s/PageLibrary inspections	with full sanitary surveys
852579E1006 conducted of	once every five years would
DC831.nsf/h_ be at least a	as stringent as performing
Toc/89E2A6F sanitary sur	veys once every three
AFEF8233285 years (which	h is what the rule requires).
2579E10071F WDNR is no	longer conducting annual
1D8/?OpenD inspections	and is transitioning to a 3
	y survey timeframe.
	made the commitment to
	luct a 3 year sanitary survey
	t the start of the 09-11
	ion 5 will track the new
	ar sanitary survey
	ommitment when 2010
	ded in the count. This is

#	Description	Type	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
1 1	Fund Utilization Rate for DW SRF	NPM/ GPRA	DWSRF	SDW-04 (Updated annually as of June 30 by HQ and tracked through DWNIMS database)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1006 DC831.nsf/h_ Toc/7999289 0A85C082F85 2579E100724 C64/?OpenD ocument&For m=h_PageUI" ]	FY10: 81% FY11: 85% w ARRA, 85% w base FY12: 90% base, 90% ARRA FY13: 87% base, 87% ARRA	the last year Region 5 will use the 5 year measurement for WI. 100% (52/52) of the sanitary surveys were completed for subpart H water systems for the 2005-2009 period. FY11: 88.9% SWTR 1.5 - 2011 Comment –88.9% (48/54) percent of community surface water systems (CWSs) underwent a sanitary survey within the past three years (five years for outstanding performers) as required under the Interim Enhanced and Long-Term I Surface Water Treatment Rules. WDNR's FY2011 target was 98%. FY12:100% FY13:100% Cumulative through: June 2010 - 89.4% June 2011 - 82.2% June 2013: *please discuss with STPB

#	Description	Туре	Used	Name	File	Target	Results
			For	Update Schedule			Related EOY Comments
8	# of projects that have	NPM/	DWSRF	SDW-05	Quickr: [	FY10: 90	Cumulative through:
	initiated operations	GPRA		(Updated	HYPERLINK	FY11: 170 w ARRA, 140 w	June 2010 - 150
				annually as of	"https://epaq	base	June 2011 - 169
				June 30 by HQ	px.rtp.epa.go	FY12: 194 w ARRA, 150 w	June 2012 - 201
				and tracked	v/QuickPlace	base	June 2013: *please discuss with STPB
				through DWNIMS	/region5state	FY13: 213 w ARRA, 169	
				database)	pwssprogram	base	
					s/PageLibrary		
					852579E1006		
					DC831.nsf/h_		
					Toc/7999289		
					0A85C082F85		
					2579E100724 C64/?OpenD		
					ocument&For		
					m=h_PageUI"		
					J		
9	% of projects awarded to	NPM/	DWSRF	SDW-11	Quickr: [	This is an indicator.	Cumulative through:
	PWS serving <500, 501-	GPRA		(Updated	HYPERLINK		June 2011 – 78%
	3,300, and 3,301-10,000			annually as of	"https://epaq		June 2012 – 78%
	consumers			June 30 by HQ)	px.rtp.epa.go		June 2013: *please discuss with STPB
				, ,	v/QuickPlace		·
					/region5state		
					pwssprogram		
					s/PageLibrary		
					852579E1006		
					DC831.nsf/h_		
					Toc/606F7A8		
					219792C7A8		
					52579E10073		
					0A1F/?Open		
					Document&F		
					orm=h_Page		
					UI"]		

#	Description	Type	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
10	# & % of small CWS and NTNCWS (<500, 501-3,300, & 3,301-10,000) w repeat health-based NO <sub>3</sub> & NO <sub>2</sub> , Stage 1 D/DBP, SWTR, & TCR violations	NPM/ GPRA	PWSS	SDW-15 (Updated annually in October by HQ)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1006 DC831.nsf/h_ Toc/770D16D 6E49B156C85 2579E100735 6D6/?OpenD ocument&For m=h_PageUI" ]	This is an indicator.	FY10: FY11: 11 of 1,881 (0.6%) FY12: 11 of 1,873 (0.6%) FY13: 10 of 1,876 (0.5%)
11	# & % of schools and childcare centers that meet all health-based DW standards	NPM/ GPRA	PWSS	SDW-17 (Updated annually in October by HQ, but can be generated from quarterly NPM measure)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1006 DC831.nsf/h_ Toc/770D16D 6E49B156C85 2579E100735 6D6/?OpenD ocument&For m=h_PageUI"	This is an indicator.	FY10: FY11: In FY11, 373 out of 398 (94%) of WI schools and childcare centers meet all health-based drinking water standards. FY12: 95.7%; 376 out of 393 FY13: 96.3%; 368 out of 382

# Office of	<b>Description</b> Enforcement and Compliance A	<b>Type</b> ssistance Nat	Used For ional Prog	Name Update Schedule ram Measure	File	Target		ults / Comments
12	During FY2012, the primacy agency must address with a formal enf action or RTC the # of priority systems equal to the # of its PWSs that have a score of 11 or higher on the July 2011 ETT report	NPM/ OECA	PWSS ECA	SDWA02 (Updated annually in July by HQ)	ETT website: [HYPERLINK "http://www. epa- otis.gov/otis/ sdwa_home. html"]	FY10: 30 FY11: 110 FY12: 120 FY13: 38	(Based on July freez FY10: 66 FY11: 134 systems ( original 110, plus ar were more recently FY12: 135 FY13: 57	54 from the an additional 80 that
	Shared Goals		l .	1 (1)		T = 202222		- avance (5)
13	<ol> <li>% of NTNCWSs meeting all health based standards</li> <li>% of TNCWSs meeting all health based standards</li> <li>% of population served by CWSs with significant/major monitoring violations</li> <li>% of CWSs with significant/major monitoring violations</li> <li>% of NTNCWSs with significant/major monitoring violations for acute health risks</li> <li>% of NTNCWSs with significant/major monitoring violations for acute health risks</li> <li>% of TNCWSs with significant/major monitoring violations for chronic health risks</li> <li>% of TNCWSs with significant/major</li> </ol>	Shared Goals		(Updated annually in April by Region 5; the milestones were revised in CY12)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579BF004 E27F5.nsf/h_ Toc/BBE0546 2326C9C9285 2579BF00590 A54/?OpenD ocument&For m=h_PageUI" ]	By CY2016: 1 = ≥95% 2 = ≥95% 3 = <5% 4 = <10% 5 = <5% 6 = <10% 7 = <10%	For CY:	For CY2012 (final 5/9/2013: 1 = 95.7% 2 = 97.3% 3 = 6.2% 4 = 18.7%* 5 = 6.7% 6 = 2.1% 7 = 2.5% * if LCR type 66 violations are excluded, then 4 = 8.9%

#	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
	monitoring violations						
Region	al Program Oversight Measures						
14	# & % Violations/Yr	Logic Model Reporting Tool (LMRT)		A6(1) (Updated annually in July by HQ)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579BF004 E27F5.nsf/h_ Toc/D66E8C9 03441233485 2579BF0059C 6E0/?OpenD ocument&For m=h_PageUI" ]		The total number of violations in WI in 2007-2011 decreased 12% (\$\\$1,755\$) from the 2004-2008 (15,069) result.  Tier 1 violations increased 6% ( $$\wedge$15$$ ) in 2007-2011 (248) as compared to 2004-2008 (233).  Tier 2 violations increased 5% ( $$\wedge$107$$ ) in 2007-2011 (2,436) as compared to 2004-2008 (2,329).  Tier 3 violations decreased 15% (\$\\$1,877\$) in 2007-2011 (10,630) as compared to 2004-2008 (12,507).  2013  The total number of violations in WI (12,752) in 2008-2012 decreased 15% (\$\\$2,317\$) from the 2004-2008 (15,069) result.  Tier 1 violations are the same in 2008-2012 (233) as compared to 2004-2008 (233).  Tier 2 violations increased <1% ( $$\wedge$20$$ ) in 2007-2011 (2,349) as compared to 2004-2008 (2,329).  Tier 3 violations decreased 19% ( $$\wedge$2,337$$ ) in 2008-2012 (10,170) as compared to 2004-2008 (12,507).

#	Description	Туре	Used Name	File	Target	Results
			For Update Schedule			Related EOY Comments
15	Cumulative # & % Non-	LMRT	O6(1)	Quickr: [		<u>2012</u>
	TCR/SWTR Violations		(Updated	HYPERLINK		The total number of chem/rad/DBP
	Responded to/Yr		annually in July by			violations in 2007-2011 (5,783)
			HQ)	px.rtp.epa.go		decreased 36% ( $\downarrow$ 3,255) from that
				v/QuickPlace		total in the 2004-2008 (9,038) period.
				/region5state		
				pwssprogram		88% (5,069) of all chem/rad/DBP
				s/PageLibrary		violations (5,783) that occurred in the
				852579BF004		five year period 2007-2011 in
				E27F5.nsf/h_		Wisconsin were reported "returned-to-
				Toc/D66E8C9		compliance" by the end of 2011.
				03441233485		
				2579BF0059C		<u>2013</u>
				6E0/?OpenD		The total number of chem/rad/DBP
				ocument&For		violations in 2008-2012 (5,436)
				m=h_PageUI"		decreased 40% ( $\downarrow$ 3,602) from that
				]		total in the 2004-2008 (9,038) period.
						83% (4,490) of all chem/rad/DBP
						violations (5,436) that occurred in the
						five year period 2008-2012 in
						Wisconsin were reported "returned-to-
						compliance" or the system was
						inactivated, by the end of 2012.
16	Cumulative # & % TCR/SWTR	LMRT	O6(1b)	Quickr: [		2012
	Violations Responded to/Yr		(Updated	HYPERLINK		The total number of TCR/SWTR/FBRR
	,		annually in July by	"https://epag		violations in 2007-2011 (4,828)
			HQ)	px.rtp.epa.go		decreased 20% (\$\square\$1,203) from that
				v/QuickPlace		total in the 2004-2008 (6,031).
				/region5state		, , ,
				pwssprogram		95% (4,592) of all the TCR/SWTR/FBRR
				s/PageLibrary		violations (4,828) that occurred in the
				852579BF004		five year period 2007-2011 in
				E27F5.nsf/h		Wisconsin were reported "returned-to-
				Toc/D66E8C9		compliance" or the system was
				03441233485		inactivated, by the end of 2011.
				2579BF0059C		

#	Description	Туре	Used For	Name Update Schedule	File  6E0/?OpenD ocument&For m=h_PageUI" ]	Target	Results Related EOY Comments  2013 The total number of TCR/SWTR/FBRR violations in 2008-2012 (4,520) decreased 25% (1,511↓) from that total in the 2004-2008 (6,031).  94% (4,244) of all the TCR/SWTR/FBRR violations (4,520) that occurred in the five year period 2008-2012 in Wisconsin were reported "returned-to-compliance" or the system was
17	Cumulative # & % "other" <u>Violations</u> Responded to/Yr	LMRT		O6(1c) (Updated annually in July by HQ)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579BF004 E27F5.nsf/h_ Toc/D66E8C9 03441233485 2579BF0059C 6E0/?OpenD ocument&For m=h_PageUI" ]		inactivated, by the end of 2012.  2012  70% (2,091) of all the "public right-to-know" (2,995) violations that occurred in the five year period 2007-2011 in Wisconsin were reported "returned-to-compliance" or the system was inactivated by the end of 2011. *  *It is important to note that query results for this indicator do not include LCR Consumer Notification.  2013  58% (1,558) of all the "public right-to-know" (2,677) violations that occurred in the five year period 2008-2012 in Wisconsin were reported "returned-to-compliance" or the system was inactivated by the end of 2012. *  *It is important to note that query results for this indicator do not include LCR Consumer Notification.
18	Violation Response Rate:	LMRT		O6(2)	Quickr: [		2012

# Description	Туре	Used	Name	File	Target	Results
		For	Update Schedule			Related EOY Comments
Estimated Median Time (in			(Updated	HYPERLINK		
days) Between Vio			annually in July by	"https://epaq		(For the 2007-2011 timeframe)
Awareness Date & Vio			HQ)	px.rtp.epa.go		
Response, over the most				v/QuickPlace		The percentage of Tier 1 violations in
recent 5 yrs				/region5state		the "1 day or less" response time
				pwssprogram		category improved to 89.07% as
				s/PageLibrary		compared to 83.26% in the 2004-2008
				852579BF004		five year period.
				E27F5.nsf/h_		
				Toc/D66E8C9		The percentage of Tier 2 violations in
				03441233485		the "30 days or less" response time
				2579BF0059C		category improved to 99.01% as
				6E0/?OpenD		compared to 97.25% in the 2004-2008
				ocument&For		five year period.
				m=h_PageUI"		The second of the 2 state the second
				]		The percentage of Tier 3 violations in
						the "> 365 days" response time category grew to 15.48% as compared
						to 7.34% in the 2004-2008 five year
						period.
						period.
						2013
						(For the 2008-2012 timeframe)
						The percentage of Tier 1 violations in
						the "1 day or less" response time
						category improved to 89.47% as
						compared to 83.26% in the 2004-2008
						five year period.
						The percentage of Tier 2 violations in
						the "30 days or less" response time
						category improved to 99.14% as
						compared to 97.25% in the 2004-2008
						five year period.

#	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
							The percentage of Tier 3 violations in the "> 365 days" response time category grew to 13.61% as compared to 7.34% in the 2004-2008 five year period.
19	Violation RTC Rate: Time (in days) between proxy vio awareness date and RTC date, over the most recent 5 yrs	LMRT		O6(2b) (Updated annually in July by HQ)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579BF004 E27F5.nsf/h_ Toc/D66E8C9 03441233485 2579BF0059C 6E0/?OpenD ocument&For m=h_PageUI" ]		2012  (For the 2007-2011 timeframe)  Tier 1  The percentage of Tier 1 violations in the "< 120 days to RTC" category decreased to 62% as compared to 66% in the 2004-2008 five year period.  Of the 52 Tier 1 violations in the "> 365 days to RTC" category, 6 were TCR and 46 were nitrate MCLs.  Of the 52 Tier 1 violations in the "> 365 days to RTC" category, 4 were from CWSs (all nitrate), 5 from NTNCWSs (all nitrate), and 43 from TNCWSs.  Tier 2  The percentage of Tier 2 violations in the "< 120 days to RTC" category decreased to 83% as compared to 89% in the 2004-2008 five year period.  Two violations endured greater than 4 years before returning-to-compliance in the 2007-2011 period. No violations endured greater than 4 years before returning-to-compliance in the 2004-2008 five year period.

#	Description	Jsed Name For Update Schedule	File	Target	Results Related EOY Comments
		For Update Schedule			Tier 3 The percentage of Tier 3 violations in the "< 120 days" return-to-compliance category decreased to 62% as compared to 75% in the 2004-2008 five year period.  Seventy violations (all PN Rule violations) endured greater than 4 years before returning-to-compliance. Nine violations endured greater than 4 years before returning-to-compliance in the 2004-2008 five year period.  2013  (For the 2008-2012 timeframe)  Tier 1  The percentage of Tier 1 violations in the "< 120 days to RTC" category decreased to 63% as compared to 66% in the 2004-2008 five year period.  Of the 44 Tier 1 violations in the "> 365 days to RTC" category, 4 were TCR and 40 were Nitrate Rule MCLs.  Of the 44 Tier 1 violations in the "> 365 days to RTC" category, 3 were from CWSs (all Nitrate Rule), 5 from NTNCWSs (all Nitrate Rule), and 36
					from TNCWSs.  Tier 2

#	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
							The percentage of Tier 2 violations in the "< 120 days to RTC" category decreased to 84% as compared to 89% in the 2004-2008 five year period.  One violation endured greater than 4 years before returning-to-compliance in the 2008-2012 period (arsenic MCL
							violation at a school). No violations endured greater than 4 years before returning-to-compliance in the 2004- 2008 five year period.
							Tier 3 The percentage of Tier 3 violations in the "< 120 days" return-to-compliance category decreased to 66% as compared to 75% in the 2004-2008 five year period.
							No Tier 3 violations endured greater than 4 years before returning-to-compliance. This is a significant improvement over last year's results. Nine violations endured greater than 4 years before returning-to-compliance in the 2004-2008 five year period.
20	# & % of Systems in Compliance with TT, MCL, and MRDL Requirements/Yr	LMRT		S5(1) (Updated annually in July by HQ)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go		2012 (For the 2007-2011 timeframe)
					v/QuickPlace /region5state pwssprogram s/PageLibrary 852579BF004		The annual number of systems with health-based violations in WI stayed consistent in 2007-2011, ranging between 381 in 2011 and 455 in 2010. The range of systems with health-

#	Description	Type	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
				•	E27F5.nsf/h_ Toc/D66E8C9		based violations in this timeframe increased slightly from the 2004-2008
					03441233485 2579BF0059C		measurement taken three years ago (range 372 – 438).
					6E0/?OpenD ocument&For		WI PWSs with Nitrate MCL violations
					m=h_PageUI"		dropped to zero in 2011 compared to a range of violations from 11 to 18 in the previous 4 years.
							The number of WI PWSs with Total Coliform violations changed significantly each year in the 2007 through 2011 period, from a low of 307 in 2009 to a high of 412 in 2010.
							WI PWSs most frequently have health-based violations for TCR. There are also a consistent number of WI PWSs that have health-based violations for arsenic, nitrate and radionuclides.
							2013
							(For the 2008-2012 timeframe)
							The annual number of systems with health-based violations in WI ranged between a low of 346 in 2012 and a high of 453 in 2010. The range of the number of systems with health-based violations in this timeframe increased from the 2004-2008 measurement taken four years ago (range 372 – 438).
							Contaminants that triggered TT, MCL, and MRDL violations at WI PWSs

#	Description	Type	Used Name For Update Schedule	File	Target	Results Related EOY Comments include, (with range of PWSs/yr in violation of that health based
						standard):  Arsenic = 6-17 PWS Barium = 0-1 PWS Carbon tetrachloride = 0-1 PWS Coliform (TCR) = 307-412 PWSs Combined radium = 2-5 PWSs Di(2-ethylhexyl)phthalate = 0 3 PWSs Gross Alpha = 1-4 PWSs HAA5 = 0 -2 PWSs LCR = 1 - 6 PWSs Mercury = 1 PWS Nitrate = 0 - 19 PWSs Nitrate-Nitrite = 3 - 12 PWSs Nitrate-Nitrite = 3 - 12 PWSs Nitrite = 0 - 1 PWS Tetracholorethylene = 0 - 1 PWS Thallium, Total = 0 - 2 PWSs TTHM = 0 - 2 PWSs
21	# & % of Systems in Compliance with M/R Requirements/Yr	LMRT	S5(2) (Updated annually in July by HQ)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579BF004 E27F5.nsf/h_		2012 (For the 2007-2011 timeframe)  The percentage of PWSs with one or more M/R violations ranged from a high of 5.6% in 2008 to a low of 4.3% in 2011.  M/R compliance rates are much higher

#	Description	Type	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
				•	Toc/D66E8C9		for transient non-community water
					03441233485		systems (TNCWS) than for community
					2579BF0059C		(CWS) or non-transient non-
					6E0/?OpenD		community (NTNCWS) water system
					ocument&For		categories even though there are many
					m=h PageUI"		more TNCWSs in Wisconsin.
					1		more mewas in wisconsin.
					]		Looking at 2004-2008 and 2007-2011
							LMRT results for this indicator, there is
							a strong trend of fewer M/R violations
							at PWSs, with the highest amount at
							1,230 in 2004 and the lowest at 499 in
							2011. All of the reduction comes from
							TNCWSs.
							1140453.
							2011 was the year with the lowest
							number and percentage of TNCWSs
							with M/R violations in the two five
							year periods reviewed (266/2.7%).
							2004 represents the year with the
							highest number and percentage
							(996/10.8%). The reduction is
							testament to the success of the county
							contract program.
							contract program.
							From 1994-2004 13 counties
							participated in this program. In 2005,
							11 counties were added; in 2006, 7
							counties; in 2008 1 county; and in
							2010, 3 counties were added. In 2012,
							there are 37 county programs,
							operating in 45 counties, that assist
							6,179 TNCWSs fulfill TCR, nitrate and
							nitrite monitoring requirements. In
							addition, the county programs also
							assist the State to fulfill sanitary survey
							requirements at TNCWSs.

#	Description	Type	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
							The additional frequency and complexity of monitoring requirements make developing similar programs to the county contract program for CWS and NTNCWSs more difficult and costly. The state resource trade-offs between increased spending to collect samples to reduce enforcement and follow-up costs should be compared carefully with operational costs to implement current policies.  2013  (For the 2008-2012 timeframe)  The percentage of PWSs with one or more M/R violations ranged from a high of 5.7% in 2012 to a low of 4.0% in 2011.  As was true last year, M/R compliance rates are much higher for transient non-community water systems (TNCWS) than for community (CWS) or non-transient non-community (NTNCWS) water system categories even though there are many more TNCWSs in Wisconsin. CWS and NTNCWS are subject to more monitoring requirements than are TNCWS.
							There was a significant increase in the number of M/R violations at WI CWSs in 2012 (n=217) as compared to any

#	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
							other year in the period 2007 – 2011. The increase is due to 2012 being the first full year in which WDNR calculated and reported lead consumer notification violations. There were 107 CWSs with lead consumer notification violations in 2012, which is approximately 10% of all CWS statewide.
22	# & % of Systems in Compliance with 'Other' Requirements/Yr*  *"other" can include violations reported for:	LMRT		S5(4) (Updated annually in July by HQ)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579BF004 E27F5.nsf/h_ Toc/D66E8C9 03441233485 2579BF0059C 6E0/?OpenD ocument&For m=h_PageUI" ]		(For the 2007-2011 timeframe)  The percentage of PWSs with one or more "other" violations ranged from a high of 4.0% in 2007 to a low of 1.4% in 2011. However, the count/percentage in the last year of a 5 year LMRT data result sequence tends to rise as late reporting from the State to SDWIS/FED in the subsequent year completes the reporting for that year.  Looking at 2004-2008 and 2007-2011 LMRT results for this indicator, there is a strong trend of fewer PWSs with "other" violations, with the highest amount at 1,058 (9.3%) in 2004.*  Results generated for the 2004-2008 period show PN violations in Wisconsin reduced significantly between 2004 and 2005.  * It is important to note that "other" violations under this indicator do not include LCR Consumer Notification.

Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
						2013
						(For the 2008-2012 timeframe)
						All WI "other" violations were for CCR or PN violations. Zero to 3 PWSs had PN violations with "76" codes each year, which are PN violations w/o a NPDWR violation.
						The percentage of PWSs with one or more "other" violations ranged from a high of 3.8% in 2007 to a low of 1.5% in 2012. However, the count/percentage in the last year of a 5 year LMRT data result sequence tends to rise as late reporting from the State to SDWIS/FED in the subsequent year is completed. You can see this reflected in the 2011 result for this indicator. From the query pulled in April 2012, 1.4% of WI PWSs had "other" violations in 2011 as compared to 2.5% from the April 2013 query.
						Approximately 10% of WI CWSs had at least one "other" violation in 2012.
New Rule Violation Completeness Reporting (GWR, LCRSTR, Stage 2/LT2	R5 High Priority	PWSS DM	(Updated in April and October by Region 5)	Quickr: [HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary		2012 October 2012 frozen database shows that WDNR has not reported any LT2 TT or M/R, GWR TT or other, or Stage 2 M/R violations. WDNR will submit the first Stage 2 M/R with the February 2013 submittal. GWR TT violations will not be reported to SDWIS/FED until
	New Rule Violation Completeness Reporting	New Rule Violation Completeness Reporting  R5 High Priority	New Rule Violation Completeness Reporting  R5 High PWSS Priority DM	New Rule Violation Completeness Reporting  R5 High Priority  R5 High Priority  DM (Updated in April and October by	New Rule Violation Completeness Reporting (GWR, LCRSTR, Stage 2/LT2  R5 High Priority DM and October by Region 5)  Wedster Schedule  Quickr: [HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /regionSstate pwssprogram	New Rule Violation Completeness Reporting (GWR, LCRSTR, Stage 2/LT2  RES High Priority DM (Updated in April and October by Region 5) Region 5) Residue: Resi

#	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
					44F09.nsf/h_ Toc/21B58BC 5FE4F337685 2579E100746 347/?OpenD ocument&For m=h_PageUI" ]		GWR TT violations are not likely to be reported until the August 2013 submittal.  2013  January 2014 frozen database shows that WDNR has not reported any LT2 TT or M/R, any GWR TT or other, or any Stage 1 TT violations. WDNR is now reporting Stage 2 M/R and LCR consumer notification violations. The scheduled FedRep upgrade has been moved back. Associated TT violations will not be reported to SDWIS/FED until at least the May 2014 submittal.
24	GW Sanitary Survey Completeness (this is a national measure beginning in FY14)	R5 High Priority	PWSS Sanitar y Survey s GWR	(Updated in April and October by Region 5)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1007 44F09.nsf/h_ Toc/39223EC 08B52359A8 52579E10080 2687/?Open Document&F orm=h_Page UI"]		2012 As of SDWIS data frozen in October 2012, there were 18.2 % (n=181) CWS, 8.5% (n=67) NTNCWS, and 8.8% (n=782) of TNs that needed to be completed by December 31st to meet sanitary survey frequency requirements.  2013 As of SDWIS data frozen in October 2013, there were 17.3 % (n=172) CWS, 7.7% (n=61) NTNCWS, and 8.0% (n=720) of TNs sanitary surveys that needed to be completed by December 31st to meet sanitary survey frequency requirements for CWSs and to meet a five year frequency for NCWSs.  WDNR provided the following information pulled from their data

#	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
							system. As of 12/17/13, there were 1.1% (12/1054) CWS, 0.6% (5/875) NTNCWS, and 0.6% (58/9457) of TNs that were late.
25	Late TCR Rule Reporting	R5 High Priority	PWSS DM TCR	(Updated annually in October by Region 5)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1007 44F09.nsf/h_ Toc/24124F3 1CD9593BB8 52579E10080 68ED/?Open Document&F orm=h_Page UI" ]		2012 Based on an analysis of 2011 TCR reporting done by Region 5, WDNR is reporting 98.7% of the violations on time, and 99.8% within one quarter after they are due.  2013 As queried from the October 2013 SDWIS frozen data set, WDNR reported more than 99% (716 of 721) of the 2012 TCR violations on-time.
26	Late Nitrate Rule Reporting	R5 High Priority	PWSS DM NO <sub>2</sub> /N O <sub>3</sub>	(Updated annually in October by Region 5)	Quickr: [ HYPERLINK "https://epaq px.rtp.epa.go v/QuickPlace /region5state pwssprogram s/PageLibrary 852579E1007 44F09.nsf/h_ Toc/0454180 D3E8D2B058		Based on an analysis of 2011 nitrate, nitrate-nitrite, and nitrite reporting done by Region 5, WDNR reported 97.8% of the violations on time, and 100% within one quarter after they are due. Also the 2010 on-time percentages improved from 64.8% in the query from the October 2011 freeze to 88.5% in the query from the October 2012 frozen database.

#	Description	Туре	Used For	Name Update Schedule	File	Target	Results Related EOY Comments
					52579E10080		2013 – As queried from the October
					EF6C/?OpenD		2013 SDWIS frozen data set, WDNR
					ocument&For		reported 100% of the 125 2012 Nitrate
					m=h_PageUI"		Rule violations to EPA on-time.
27	Arsenic MCL Non-compliance	NEW R5	PWSS	(Updated	Quickr: [		FY11 - As per the January 2012 frozen
		High	As	quarterly by HQ—	HYPERLINK		database, WI reported 7 active systems
		Priority		NPM Measures	"https://epaq		with arsenic health-based violations.
				Tables filtered for	px.rtp.epa.go		
				active, non-RTC'd	v/QuickPlace		FY12 – As per the January 2013 frozen
				arsenic MCL	/region5state		database, WI reported 5 active systems
				violations)	pwssprogram		with arsenic health-based violations.
					s/PageLibrary		
					852579E1007		FY13 – As per the January 2014 frozen
					44F09.nsf/h_		database, WI reported 3 active systems
					Toc/EBF08B0		with arsenic health-based violations.
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# FY2013 WI DNR PUBLIC WATER SYSTEM SUPERVISION PROGRAM WORK PLAN END-OF-YEAR REPORT

October 1, 2012, through September 30, 2013

Reported as of 2/15/14

#### Contacts:

- WI DNR Public Water Supply Section Chief Steve Elmore, [ HYPERLINK "mailto:Steve.Elmore@wisconsin.gov"], (608) 264-9246
- U.S. EPA Region 5 (R5) WI State Program Manager Joe Janczy, [ HYPERLINK "mailto:Janczy.Joseph@epa.gov"], (608) 267-2763

**Federal funding used:** PWSS grant; Drinking Water State Revolving Fund (DWSRF) State program management, local assistance (for capacity development and wellhead protection), and small system technical assistance set-asides; Operator Certification Expense Reimbursement grant; and Clean Water Act Section 106 funds (ground water)

NOTE: Click on the links below for summaries and more detailed information about WI's implementation of the national primary drinking water regulations (NPDWRs) or any of the activities below.

#### 1. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 BBF6.nsf/h\_Toc/a4c0568ac09b2fc5852579c700161d51/?OpenDocument"] —WI DNR implements the vast majority of NPDWRs as required, and takes actions to improve oversight to protect public health. Recent examples include:

- Instructed all labs and contracted counties to reject Total Coliform Rule (TCR) samples that are held greater than 30 hours
- Automated the generation of TCR repeat monitoring violations when extensions endure longer than 10 days
- evaluating use of the discretion to allow a non-community water system (NCWS) to operate if nitrate levels do not exceed 20 mg/L

WI DNR applied for primacy for Filter Backwash Recycling Rule (FBRR), Long-Term 2 Surface Water Treatment Rule(LT2), Ground Water Rule (GWR), Lead and Copper Rule Short-Term Revisions (LCRSTR), Stage 2 Disinfectants/Disinfection By-Products Rule (Stage 2), Variances & Exemptions (V&E), and a number of minor NPDWR revisions. R5 completed review of the GWR primacy application and the LCRSTR. Specific revisions are necessary and R5 comments have been provided. R5 expects to complete its review of the rest of the application except for minor NPDWR revisions by July 31, 2014. R5 is tracking state reporting of new rule violations (LT2, GWR, LCR, and Stage 2). As of January 2014, WI DNR had reported:

- No LT2 violations
- 335 GWR source water M/R violations
- No GWR TT or other violations
- 32 Stage 2 violations
- 382 LCRSTR consumer notification M/R violations

#### 2. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 7D04.nsf/h\_Toc/9ba56cee8247ce01852579c700167798/?OpenDocument"] — From 2010-2012, WDNR completed sanitary surveys at each WI surface water CWSs (55/55). This exceeded WDNR's negotiated target of 87% and surpassed the 95% national target. As of December 31, 2012, a sanitary survey must be conducted at each ground water CWSs every three years. For 2011-2013, WDNR reports being close to meeting this requirement (98.9% as of 12/17/13). WDNR expanded the county contract program, helping WDNR meet frequency requirements at transient non-community water systems. WDNR reports active review of the sanitary survey program both internally and with contracted counties. WDNR is taking steps to stabilize recent staff turnover.

#### 3. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70016 055A.nsf/h\_Toc/50a7a2f7c68b0990852579c7001671af/?OpenDocument"] — The state is meeting expectations because: (1) USEPA-Region 5 maintains certification for the Wisconsin State Laboratory of Hygiene, (2) the program uses direct certification and reciprocal agreements to certify commercial labs within the state, and (3) a process for ensuring capacity to analyze at the principal state lab or commercial labs all NPDWR parameters that are required to be sampled in the state is maintained. Laboratory certification responsibilities in Wisconsin are split between the WI DNR (chems), and WI DATCP (micro).

WI DNR will certify laboratories for radionuclides and asbestos in 2014 based on the laboratories' accreditation by the National Laboratory Accreditation Program (NELAP). The Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP) will certify laboratories for *Cryptosporidium*.

#### 4. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 D26C.nsf/h\_Toc/d247c4442932350b852579c700165c4b/?OpenDocument"]—WI DNR ensures public water systems regain compliance with NPDWRs. R5 tracks state commitments under measure SDWA02 and updates WI DNR quarterly. WI DNR met their SDWA O2 measure commitments, tightened enforcement of the TCR, and commits to full PN, CCR and lead consumer notification enforcement beginning in 2014. WI DNR is collecting monthly operating report information electronically from PWSs. This will assist them in determining compliance with the operation and maintenance requirements at public water systems that treat drinking water and are required to monitor treatment performance.

#### 5. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 9C89.nsf/h\_Toc/f773ba3fde21dac7852579c7001641c9/?OpenDocument"]— WI DNR maintains a data management system that tracks requirements for all rules and serves as the central store of data reported by laboratories, field offices and County Health Departments. WI DNR uses FedRep 3.2, but needs to upgrade to 3.4, to report TT and "other" violations to EPA. WI DNR anticipates having FedRep 3.4 in place to report missing violation categories by the May 2014 submittal. R5 is very impressed with WI DNR's exceptional timeliness of reporting TCR and nitrate violations to SDWIS/FED.

6. Security – WI DNR is expected to adopt and implement an adequate plan for the provision of safe drinking water under emergency circumstances including, but not limited to, earthquakes, floods, hurricanes, and other natural disasters. R5 will review state emergency plans and consult with the state on implementation capabilities.

#### 7. [ HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 8EB5.nsf/h\_Toc/919b620e10f28d06852579c7001669e9/?OpenDocument" ] —WI DNR keeps water operators certified and ensures at least one certified operator at CWSs and NTNCWSs. Pass rates for municipal waterworks operators indicate exams are challenging. Wisconsin offers many opportunities for water system operation education to attain continuing education credits. It would be useful for WI DNR to track the number of water systems that maintain at least one certified operator at the appropriate subclass level for that water system in future reports.

#### 8. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 8751.nsf/h\_Toc/b64a188dd87b1337852579c70016637d/?OpenDocument" ] —WI DNR ensures that new and existing CWSs/NTNCWSs can demonstrate technical, managerial, and financial capacity to operate in compliance with federal and state regulations. WI DNR provided documentation to R5 showing ongoing implementation.

Twenty-six percent of WI water systems that began operation as CWSs or NTNCWSs in the 2011-2013 period (n=84), incurred monitoring, operator certification, lead consumer notification, and/or public notification violations in the same three year period.

R5 recommends WI DNR review its new systems program in order to determine if problems with non-compliance are related to the speed of initial contact with the new system or if violations occur after initial contact. Region 5 suggests tracking the speed of initial contact periodically as an indicator of new system program performance. We suggest WI DNR increase focus on new systems in its approaches to implement the operator certification program and/or technical assistance contracts.

#### 9. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 F083.nsf/h\_Toc/383d4a88413b802e852579c700167d85/?OpenDocument"] —WI DNR reported the number of CWSs with source water protection (SWP) plans and the number of CWSs implementing SWP measures (electronically via SDWIS, if possible) as of June 30 by August 15. For FY13, WI DNR reports minimizing risk through source water protection at 15% of WI CWSs and 16% of the CWS population, exceeding their targets of 13% and 14% respectively. WI DNR 2013 highlights include—

- Adopted a strategy for selecting PWSs for intensive WHP planning and implementation assistance.
- Coordinated with USDA-NRCS to select NWQI subwatersheds with 3-4 PWSs approaching unsafe levels of nitrate
- Sought agricultural producer collaborators in Sauk County to implement a nitrate demonstration project.

- Collaborated with the WI Dept of Health Services on an interim Health Advisory Level for molybdenum.
- Presented a heat exchange drilling rule for Natural Resource Board adoption.
- For selected regulated CAFOs, worked to develop groundwater modeling and monitoring approach to evaluate potential environmental impacts and to facilitate compliance with groundwater standards.

#### 10. [HYPERLINK

"https://epaqpx.rtp.epa.gov/QuickPlace/region5statepwssprograms/PageLibrary852579C70015 F8CA.nsf/h\_Toc/dd322cacf7ab97ca852579c7001687eb/?OpenDocument"] —There are multiple national measures in the national program manager guidance that support the "water safe to drink" subobjective 2.1.1 in EPA's strategic plan. R5 is also tracking several other measures, including those in the logic model reporting tool, regional shared goals, and regional high priority queries. The most recent data for Wisconsin for each of these measures are available via the "measures and indicators" link, some of which have been described above in this work plan summary.

#### Other highlights include:

- WDNR responds quickly to Tier 1 and Tier 2 violations (from indicator 18)
- WDNR reduced down from 77 to 0 the number of Tier 3 violations reported to SDWIS that endured greater than 4 years before returning-to-compliance (from indicator 19)
- Active systems with arsenic violations were reduced from 7 in FY11 to 3 in FY13 (from indicator 27)
- The overall number of M/R violations went up mainly because of LCR consumer notification (from indicators 13.4 and 21)
- One arsenic MCL violation at a school endured > 4 years before returning to compliance (from indicator 19)
- The percentage of Tier 3 violations in the ">365 days" response time category grew to 13.61% in the 2008-2012 period as compared to 7.34% in the 2004-2008 period (from indicator 18)
- 11. Resources and expertise —WI DNR maintains a baseline core of individuals with the technical expertise to carry out all mandatory components of the PWSS Program (including engineering plan and specification review and emergency response). Contracts with third parties conducting mandatory components of the PWSS Program will make performance expectations clear, and will be measured and evaluated by the Department. WI DNR uses the *State Drinking Water Program Resource Needs Report & Recommendations* to develop and implement a plan to provide adequate funding to carry out all functions of the PWSS program. R5 to track progress related to state and EPA efforts to obtain additional resources necessary to enable WI DNR to engage in resolving program discrepancies.

# UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION 5

IN THE MATTER OF:	)
Alternative Lead in Drinking Water Reduction Treatment Technique for Wisconsin Public Water Systems	) SECTION 1415(A)(3) OF

#### INTRODUCTION

#### 1. Statutory and Regulatory Background

Under the Safe Drinking Water Act, 42 U.S.C. '' 300f-300j-26 (SDWA), U.S. EPA promulgates national primary drinking water regulations (NPDWRs), which specify for certain drinking water contaminants either a maximum level or treatment technique with which public water systems (PWSs) must comply. U.S. EPA has promulgated an NPDWR for lead and copper, the lead and copper rule (LCR), 40 C.F.R. Part 141, Subpart I, that consists of a treatment technique requiring PWSs to take various steps to ensure that users of their system are not exposed to levels of lead and/or copper in drinking water that would result in adverse health effects. LCR requires all Community Water Systems (CWSs) and Non-Transient Non-Community Water Systems (NTNCWSs) to optimize corrosion control and to conduct tap water monitoring to ensure that lead and copper levels are minimized at users= taps. If tap water levels exceed either Aaction level@ (AL) of 0.015 mg/L for lead or 1.3 mg/L for copper, in more than 10 percent of drinking water tap samples (i.e., exceeds the AL as a 90th percentile value), PWSs are required to take additional steps, including delivering public education materials to users about the health risks of lead in drinking water (for lead AL exceedances), treating source water if it contains elevated lead and/or copper levels, or installing corrosion control treatment (CCT). For systems that continue to exceed the lead AL after optimizing CCT, the system must begin replacing at least seven percent of lead service lines (LSLs) in the system per year. LSLs that contribute less than 0.015 mg/L of lead do not need to be replaced and can be counted toward the number of LSLs required to be replaced.

The State of Wisconsin has primary enforcement responsibility for administering the LCR because it has adopted regulations that are at least as stringent as the federal regulations. See Wisconsin Administrative Code [insert code citation]. The State regulation currently applies to all CWSs and NTNCWSs in Wisconsin.

U.S. EPA has the authority to grant a variance from any treatment technique upon a showing by any person that the alternative treatment technique is at least as efficient in lowering the level of that contaminant in drinking water. Section 1415(a)(3) of SDWA, 42 U.S.C. '300g-4(a)(3), provides:

AThe Administrator may grant a variance from any treatment technique requirement of a national primary drinking water regulation upon a showing by any person that an alternative treatment technique not included in such requirement is at least as efficient in lowering the level of the contaminant with respect to which such requirement was prescribed. A variance under this paragraph shall be conditioned on the use of the alternative treatment technique which is the basis for the variance. @

See also 40 C.F.R. ' 142.46.

## 2. Factual Background

U.S. EPA and the Wisconsin Department of Natural Resources (WDNR) have agreed on the need to better integrate implementation of the statutory and regulatory requirements under the Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) to protect public health and improve our nation's environment. Therefore, the U.S. EPA and WDNR have agreed to establish a more effective approach to reducing the lead levels in drinking water which would also reduce the phosphorus loadings in Wisconsin waters. The U.S. EPA and WDNR have concluded that successful projects demonstrate that in some cases, changes in U.S. EPA regulations, policies, quidance, or interpretations are needed to improve upon the nation's existing public health and environmental protection system. Where such changes can be made under existing law, U.S. EPA agrees to initiate the process for making the changes -following applicable procedures.

The LCR requires that all systems optimize corrosion control to minimize lead and copper levels at consumers' taps. Many systems currently utilize orthophosphate as the primary lead and copper corrosion control mechanism and the addition of orthophosphate has been effective at reducing lead and copper levels in drinking water under the SDWA. The allowable discharge limits for phosphorus into receiving waters are being lowered under the CWA in Wisconsin such that the amount of orthophosphate being added as part of the Optimal Corrosion Control Treatment (OCCT) for SDWA compliance would require certain entities under the CWA to install treatment to remove the phosphorus prior to being able to

discharge into receiving waters even where they have added none of the phosphorus themselves (e.g., entities using potable water in non-contact cooling water applications that is discharged to receiving waters). Almost all lead and copper comes from plumbing materials transporting drinking water to the homes via the distribution system and from plumbing within the homes themselves, therefore there is no possibility to remove these contaminants at the drinking water treatment plant.

A SDWA ban on the use of leaded solder and other leaded materials became effective in 1988 with subsequent additions and modifications to the law since then. It is no longer permissible to install most leaded materials in potable water applications within a public water system or premise plumbing. While the SDWA prohibits the introduction of most leaded materials into the plumbing network, it does not require the removal of existing lead sources. Lead service lines (LSLs), leaded brass and to a more limited extent leaded solder continue to leach lead into the drinking water, with the largest contributor overall being LSLs. The available options for effectively reducing lead and copper levels in PWSs with LSLs without the use of orthophosphate are very limited and could require significant additional water quality and operational changes, including capital improvements.

Many of the same entities regulated under both the CWA and SDWA must comply with lead in drinking water reductions under the SDWA and phosphorus discharge limits under the CWA. To accomplish this, a PWS with LSLs may be required to increase the level of orthophosphate necessary to control lead and copper corrosion at the drinking water plant and to also install treatment to remove the same orthophosphate they have added to the drinking water prior to being able to discharge into receiving waters under the CWA.

The Wisconsin Department of Natural Resources (WDNR) has proposed an alternative treatment technique for compliance with the LCR. WDNR believes that this alternative treatment technique will be more efficient than the LCR treatment technique in lowering lead and copper levels. WDNR proposes that this alternative treatment technique be allowed for certain Public Water Systems (PWSs) in Wisconsin that meet specific criteria. The alternative treatment technique specified in this variance contains a number of provisions, including the permanent removal of all LSLs, including all privately-owned portions of LSLs, within a PWS to lower the levels of lead in the drinking water, along with a corresponding re-evaluation of existing State OCCT designations, with the intent of modifying the State-designated OCCT to eliminate or reduce the level of orthophosphate addition to the water supply once all LSLs,

including all privately-owned portions of LSLs, have been removed from the PWS.

- U.S. EPA, Region 5, has reviewed WDNR=s proposal and believes that the proposal has merit and that the alternative treatment technique will be at least as efficient in lowering the level of lead and/or copper in drinking water as the existing treatment technique under the LCR.
- U.S. EPA has identified a variance, pursuant to Section 1415(a)(3) of SDWA, 42 U.S.C. ' 300g-4(a)(3), as the appropriate legal mechanism for providing the regulatory flexibility which WDNR The variance allows certain PWSs to use the has requested. alternative treatment technique where specific conditions are met, in lieu of specific LCR requirements. The variance establishes participation criteria that a PWS must meet in order to qualify for the alternative treatment technique. The variance also sets forth the performance criteria that the PWS must meet to continue to be allowed to use this alternative treatment technique. To ensure that the alternative treatment technique is as effective as possible, and provides at least an equivalent level of protection as the existing regulations, U.S. EPA and WDNR have entered into a Memorandum of Understanding (MOU) describing the roles responsibilities of each agency in implementing the variance. MOU provides for oversight criteria, which WDNR will follow, to insure the proper implementation of the variance and the use of this alternative treatment technique.

#### FINDINGS OF FACTS

- 1. This matter comes before the Regional Administrator of U.S. EPA, Region 5, on request by WDNR, for a State-wide variance pursuant to Section 1415(a)(3) of SDWA, 42 U.S.C. '300g-4(a)(3).
- 2. Pursuant to Section 1401(4)(A) of SDWA, 42 U.S.C. '300f(4)(A), a PWS is a system that provides drinking water to the public for human consumption through pipes or other constructed conveyances, and that has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.
- 3. A CWS is a PWS which serves at least 15 service connections used by year round residents or regularly serves at least 25 year-round residents.
- 4. An NTNCWS, is a PWS that is not a CWS, and that regularly serves at least 25 of the same persons over 6 months per year.

- 5. Pursuant to Section 1401(1)(A) of SDWA, 42 U.S.C. '300f(1)(A), because CWSs and NTNCWSs are PWSs, certain NPDWRs apply to CWSs and NTNCWSs.
- 6. The LCR requires all CWSs and NTNCWSs to comply with the regulatory requirements specified at 40 C.F.R. ' 141.80 through ' 141.91.
- 7. WDNR requests that a State-wide variance be granted, allowing PWSs meeting specific qualifying criteria to use the alternative treatment technique outlined in this variance in lieu of complying with specific regulatory provisions outlined in the LCR.

## CONCLUSIONS OF LAW

- 1. Section 1415 (a)(3) of SDWA, 42 U.S.C. '300g-4(a)(3), and 40 C.F.R '142.46, authorize the Administrator to grant a variance from a treatment technique of an NPDWR:
  - A...upon a showing by any person that an alternative treatment technique not included in such requirement is at least as efficient in lowering the level of the contaminant with respect to which such requirement was prescribed. A variance under this paragraph shall be conditioned on the use of the alternative treatment technique which is the basis for the variance.@
- 2. The authority to issue SDWA variances for treatment technique requirements was delegated to the Regional Administrators on June 12, 2000. Delegation 9-69, Issuance of Variances for Treatment Technique Requirements.
- 3. PWSs in Wisconsin will be eligible upon application to and approval by WDNR, for this variance only if all of the following conditions are satisfied:
  - a. The PWS has signed a legally-binding agreement with the WDNR to remove all LSLs, including all privately-owned portions of LSLs, within no more than [15 years] from the date of such agreement, unless a lesser amount of time is specified by the WDNR.
  - b. Any PWS with LSLs that receives water from a PWS which has agreed to participate in this variance must also agree to participate in this variance unless they are responsible for maintaining their own optimal CCT.
  - c. All participating PWSs must demonstrate to the satisfaction of U.S. EPA and the WDNR that they have the legal authority to require the removal of all LSLs, including all privately-owned portions of LSLs.

- d. PWSs must agree to all terms and conditions outlined in sections 4 and 5 of this variance, in the agreement established under [section xx] of this variance.
- 4. The PWS must do all of the following specified in this [paragraph/section/subsection] in lieu of complying with the requirements specified in 141.80 through 141.82, 141.84, 141.86, 141.87 and 141.88. The requirements specified in this paragraph (4) constitute the alternative treatment technique:
  - a. Maintain the State-designated and approved OCCT that is in place upon the effective date of this variance, until all LSLs are fully removed and the State has provided written approval to modify the PWS' existing OCCT in accordance with [section xx] of this variance.
  - b. Compile an inventory of all LSLs within the PWS' distribution system, including privately-owned portions of LSLs, using the process described in [section xx or paragraph xx of this variance].
  - [LISTNUM AutoList36 \l 1] Provide educational material to property owners and residents with LSLs or portions of LSLs regarding the PWS' planned LSL removal program which includes the following:
    - 1. The benefits of LSL removal;
    - 2. Health effects information, including the potential for particulate lead release following LSL removal and flushing instructions to minimize the potential for ingestion of released lead particles;
    - 3. Information regarding the cost, if any, to homeowners for replacing the privately-owned portion of the LSL, including any financing options available to homeowners;
    - 4. Conduct diagnostic monitoring for lead and copper at the taps on an annual basis during the months of June through September for the duration of the schedule for LSL removal in lieu of compliance monitoring under 40 CFR 141.86. Monitoring for lead and copper at the taps shall be used to assess the effectiveness of LSL removal activities and to provide information to the U.S. EPA, WDNR and the public; this data shall not be used in 90th percentile compliance calculations to trigger additional actions by the PWS under the LCR.
  - d. Conduct diagnostic monitoring for water quality and process control parameters as specified by the WDNR for the duration of the schedule for LSL removal in lieu of compliance monitoring under 40 CFR 141.87. Monitoring for water quality and process control parameters as specified by WDNR shall be used to assess the effectiveness of OCCT as well as the water quality characteristics at the entry

- points and within the distribution system; this data shall not be used to determine compliance with the LCR TT for OWQCPs under the LCR.
- e. Conduct source water monitoring for lead, copper and water quality parameters as specified by the State.
- [LISTNUM AutoList38 \l 1] Use EPA approved analytical methods for contaminants and parameters monitored under this variance.
- [LISTNUM AutoList38 \l 1] Comply with all applicable LCR requirements (e.g., recordkeeping and reporting) specified in 141.90 and 141.91 and any additional recordkeeping and reporting requirements specified by WDNR in the agreement specified in [paragraph x].
- i. Remove all LSLs within the public water system, including any portions of LSLs not owned by the PWS not later than [15 years] from signing the agreement in [paragraph xx] Submit a request to WDNR for the elimination or reduction in orthophosphate levels used for OCCT, including any information requested by WDNR and included in the agreement specified in [paragraph xx].
- 6. The actions specified in Paragraph 4 above, will be incorporated into individual agreements between WDNR and each participating PWS specified in [subparagraph xx].
- 7. The individual agreements will set the time frames for submitting assessments, demonstrations, sample results, designations, and other actions required by this variance, including any additional requirements specified by WDNR.
- 8. WDNR will review and act on all submittals in accordance with its existing PWS oversight program.
- 9. U.S. EPA and WDNR have entered into an MOU, which will become effective upon the finalization of this variance, and which describes each agency=s responsibilities regarding the variance and the alternative treatment technique.
- 10. Approval for the use of the alternative treatment technique will be determined on a case-by-case basis.

#### ORDER

#### It is therefore ordered:

That in consultation with WDNR, the Regional Administrator, U.S. EPA, Region 5, finds that WDNR has made a showing for a variance under Section 1415(a)(3) of SDWA. WDNR=s request for a State-wide variance is granted, subject to the following conditions:

- 1. All participating PWSs meet the eligibility criteria outlined in [paragraphs xx and xx] of this variance, above.
- 2. All participating PWSs meet the participation criteria outlined in [paragraph xx] of this variance, above. Failure to comply with the participation criteria in [paragraph xx] will automatically terminate the PWS= eligibility for this variance.
- 3. This variance shall terminate:
  - d. Upon termination of the MOU by either WDNR or U.S. EPA; or
  - e. Upon a determination by U.S. EPA or WDNR that the alternative treatment technique no longer provides the same level of public health protection as the requirements under the LCR.
- 5. In the event that the variance terminates, all PWSs subject to this variance shall be required to comply with all requirements under the LCR.
- 6. The Regional Administrator shall retain jurisdiction and shall annually review the circumstances pertaining to the variance, and may modify or revoke the variance if any provisions or conditions are not met.
- 7. Nothing in this Order alters or otherwise affects any requirement applicable under the State law.

Dated:	
	Susan Hedman
	Regional Administrator

# Orthophosphate Reduction Based on Removal of Lead Service Lines (LSLs)

# **Proposal**

As part of a commitment to better integrate the Clean Water Act (CWA) and Safe Drinking Water Act (SDWA), the United States Environmental Protection Agency (EPA) and Wisconsin Department of Natural Resources (WDNR) are proposing to expand upon a recent successful approach to simultaneously achieve permanent reductions in the amount of lead in drinking water and phosphorus loadings to ambient waters in Wisconsin.

On the SDWA side, this approach would provide a more effective, permanent means of addressing health concerns from lead in drinking water and reduces the likelihood of compliance complications with other drinking water regulations.

On the CWA side, this approach would result in elimination of, or a permanent reduction in, the phosphate levels in the drinking water; elimination of the need for treatment installation for many PWSs and entities using potable water for non-contact cooling water; reduction in the amount of phosphorus run-off from landscaping and lawn care activities; and an overall reduction in the amount of phosphorus loadings to Wisconsin waterways.

# **Background**

Under the SDWA, the Lead and Copper Rule (LCR) requires, among other things, that all systems optimize corrosion control to minimize lead and copper levels at consumers' taps. Many systems currently utilize orthophosphate as the primary lead and copper corrosion control mechanism. The addition of orthophosphate has been proven to be effective in significantly reducing the corrosion of lead and copper into the drinking water. While the addition of orthophosphate has been effective at reducing lead and copper levels in drinking water under the SDWA, the allowable discharge limits for phosphorus into receiving waters are being lowered under the CWA such that the amount of orthophosphate being added as part of the Optimal Corrosion Control Treatment (OCCT) for SDWA compliance would require certain entities under the CWA to install treatment to remove the phosphorus prior to being able to discharge into receiving waters, even where they have added none of the phosphorus themselves (e.g., drinking water plant discharges and potable water used in non-contact cooling water applications that is discharged to receiving waters). Since almost all lead and copper comes from plumbing materials transporting drinking water to the homes via the distribution system and from plumbing within the homes themselves, there is no possibility to remove these contaminants at the drinking water treatment plant.

A SDWA ban on the use of leaded solder and other leaded materials became effective in 1988 with subsequent additions and modifications to the law since then. As a consequence, it is no longer permissible to install most leaded materials in potable water applications within a public water system or premise plumbing. While the SDWA prohibits the introduction of new leaded materials into the plumbing network, it does not require the removal of existing lead sources. Consequently, lead service lines, leaded brass and to a more limited extent leaded solder

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continue to leach lead into the drinking water, with the largest contributor overall being lead service lines (LSLs).

Studies conducted since 1991 have shown that lead levels in drinking water can be significantly higher than compliance data suggests due to an outdated and ineffective sampling protocol in the current rule. LSLs are made of solid lead and are very durable and as a result, millions of LSLs or portions of LSLs, many of which were installed over 100 years ago, are still in service today. Health effects research also continues to reinforce that there is no safe level of lead exposure and even low level lead exposures are harmful to infants, children and pregnant women. These new studies and information could result in a requirement to increase the amount of orthophosphate added to the drinking water at the treatment plant as part of the LCR revisions currently under consideration. However, while this may lower lead levels, research also shows that for homes served by LSLs, it is not possible to completely eliminate lead from the drinking water, even with the addition of orthophosphate to control corrosion. There will always be a measureable amount of lead in the drinking water, even where the drinking water taps are flushed prior to use. The available options for effectively reducing lead and copper levels in PWSs with LSLs without the use of orthophosphate are very limited and could require significant additional water quality and operational changes, including capital improvements.

Many of the same entities regulated under both the CWA and SDWA must comply with lead in drinking water reductions under the SDWA and phosphorus discharge limits under the CWA. To accomplish this, a PWS with LSLs may be required to increase the level of orthophosphate necessary to control lead and copper corrosion at the drinking water plant and to also install treatment to remove the same orthophosphate they have added to the drinking water prior to being able to discharge into receiving waters under the CWA.

A potential solution, which would allow a reduction rather than an increase in the amount of orthophosphate use for drinking water treatment is the removal of all LSLs in a PWS. The removal of all LSLs, in conjunction with the SDWA ban on introducing new leaded materials into public water systems can significantly reduce the amount of orthophosphate needed to minimize lead levels at consumers' taps. The effectiveness of this approach for lead reduction was demonstrated by the City of Madison, Wisconsin. Madison, WI exceeded the lead AL in 1992, and again in 1997 and was required to install OCCT. Rather than installing and maintaining OCCT on a permanent basis and potentially increasing the nutrient levels in the nearby water bodies, the City proposed to remove all LSLs within the City in lieu of installing OCCT. The U.S. EPA and WDNR agreed that the City's proposal would result in the permanent removal of the most significant lead sources while not increasing the nutrient loadings in the nearby water bodies.

The City began removing LSLs in 2001 and completed these activities in 2010. Although some homes still experienced occasional lead release after the removal of the entire LSL, this was primarily due to lead particles deposited in the home plumbing that were released from the lead service lines and which would periodically come loose from the internal plumbing. Without the presence of the source material (LSLs) depositing additional lead into the home plumbing, lead levels have decreased to very low levels. The 90<sup>th</sup> percentile values for the 202 compliance samples collected in the last two six-month rounds of compliance monitoring in 2011 were 2.6

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 $\mu$ g/L and 3.6  $\mu$ g/L, with the average lead level for these two rounds of monitoring being 1.75  $\mu$ g/L.

# Cost-effectiveness of LSL replacement as an alternative to the addition of orthophosphate for corrosion control.

The benefits to public health from removal of lead sources have consistently been demonstrated to outweigh the costs, and the overall benefits from an integrated CWA/SDWA approach are many. A reduction in orthophosphate addition at the drinking water plants would also reduce phosphorus loadings in the potable water and waste water. A reduction in orthophosphate levels in potable water could eliminate the need for PWSs and entities using potable water for non-contact cooling water to install phosphorus removal treatment prior to being able to discharge to receiving waters, and lower the levels of available nutrients in receiving waters. A reduction in available nutrients in ambient waters can reduce the amount of organic growth, such as algae, in ambient waters. Since organic matter reacts with chlorine added at the drinking water plants to form harmful disinfection byproducts in the drinking water, the amount of treatment needed under the SDWA to remove total organic carbon (TOC) loadings from the raw water at the drinking water treatment plant may also be reduced by eliminating the additional phosphorus loadings to the ambient waters. Thus, an integrated CWA/SDWA approach represents a more comprehensive solution than trying to address the statutory and regulatory requirements of the CWA and SDWA independently.

Conversely, should the required level of orthophosphate for corrosion control increase under the LCR revisions, the additional phosphorus loadings in corresponding discharges can contribute to higher TOC levels in ambient waters, potentially requiring the adjustment of TOC removal treatment at drinking water plants using these waters, as well as the potential need for installation of new treatment to remove increased levels of disinfection byproducts from the finished water. The need for additional TOC removal to comply with SDWA regulatory limits on disinfection by-product precursor material (TOC) may prompt systems to switch to a more effective coagulant to accomplish the required TOC removal such as ferric chloride, which in turn can alter the water chemistry and result in increased lead levels in the drinking water.

The overall benefits to public health and the environment from an integrated CWA/SDWA approach would be substantial, resulting in the permanent removal of the largest sources of lead in drinking water and a permanent reduction in the amount of phosphorus discharged to receiving waters.

# Integrated CWA/SDWA Approach

The intent of OCCT is to minimize lead and copper levels at consumers' taps. The LSL removal requirements are designed to protect public health by removing lead sources that are not controllable even where the corrosion control treatment has been optimized.

Under the LCR, public water systems (PWSs) have already installed and are currently operating OCCT. Should a PWS exceed the lead 'action level' (AL) of 15 ug/L after installing OCCT, the PWS is required to undertake additional actions to protect public health, including the removal of

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portions of any LSLs that are owned by the PWS at a rate of 7 percent of the total number of LSLs per year for as long as the PWS continues to exceed the lead AL. A PWS is allowed to stop LSL removal activities once the PWS demonstrates that the lead AL has been met for two 6-month monitoring periods. Under the LCR, a PWS may also consider a LSL to be replaced without actually physically removing any portion of the LSL if all water samples collected from within a LSL demonstrate that the lead levels within that LSL are below the lead AL.

The Lead and Copper Rule is a Treatment Technique regulation under the SDWA, and U.S. EPA has the authority under Section 1415(a)(3) of the SDWA to grant variances from treatment technique requirements as follows:

SEC. 1415. (a) Notwithstanding any other provision of this part, variances from national primary drinking water regulations may be granted as follows:

\*\*\*

(3) The Administrator may grant a variance from any treatment technique requirement of a national primary drinking water regulation upon a showing by any person that an alternative treatment technique not included in such requirement is at least as efficient in lowering the level of the contaminant with respect to which such requirement was prescribed. A variance under this paragraph shall be conditioned on the use of the alternative treatment technique which is the basis of the variance.

Using this SDWA variance provision, U.S. EPA may allow a PWS to specify an alternative treatment technique requiring the removal of all LSLs and portions of LSLs within the public water system over a specified timeframe along with performance of other actions such as flushing and public education, in lieu of permanently maintaining the current orthophosphate levels specified in the State's OCCT determination, or increasing the amount of orthophosphate used under potential revisions to the LCR. In addition, the PWS commitment to remove all LSLs over a specified timeframe could provide the basis for replacing the triggered LSL replacement requirements under the LCR should a PWS exceed the lead AL during the timeframe specified for replacing all lead service lines under the variance. This would allow a PWS to plan and conduct LSL replacement in an orderly fashion, rather than having to hastily implement a triggered LSL replacement program each time the PWS exceeds the lead AL.

The variance provisions could stipulate the steps/conditions/monitoring once all LSLs are removed, for a PWS to begin reducing orthophosphate levels. Alternatively, if legally possible, the PWS could submit a request to the State for a re-designation of OCCT under 40 CFR 141.82(h) demonstrating that the current level of orthophosphate is no longer needed based on the removal of all of the LSLs. This provision is intended to ensure that a PWS maintains adequate corrosion control treatment. It may also be appropriate to consider modifications to State-designated OCCT under this provision where it is determined that the existing level of treatment is no longer necessary to minimize lead levels based on the removal of major lead sources and retaining the existing treatment may impact PWS compliance with other drinking water regulations. The State would then be able to modify its OCCT designation to eliminate or permanently reduce the amount of orthophosphate required to be used by the PWS.

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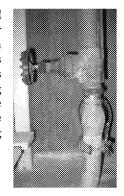
# Detection and Evaluation of Elevated Lead Release from Service Lines: A Field Study

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Supporting Information

ABSTRACT: Comparative stagnation sampling conducted in 32 homes in Chicago, Illinois with lead service lines demonstrated that the existing regulatory sampling protocol under the U.S. Lead and Copper Rule systematically misses the high lead levels and potential human exposure. Lead levels measured with sequential sampling were highest within the lead service lines, with maximum values more than four times higher than Chicago's regulatory compliance results using a first-draw sampling protocol. There was significant variability in lead values from different points within individual lead service lines and among different lead service line sites across the city. Although other factors could also influence lead levels, the highest lead results most often were associated with sites having known disturbances to the lead service lines. This study underscores the importance and interdependence of sample site selection, sampling protocol, and other factors in assessing lead levels in a public water system.



#### INTRODUCTION

**Background.** Most lead in drinking water comes from premise plumbing materials and lead service lines (LSLs). LSLs are generally the largest source of lead in drinking water when they are present in public water systems. The 1986 Safe Drinking Water Act Amendments banned new lead pipes in the potable water network, but a legacy of millions of partial or whole LSLs remains in many public water systems. Where the term "lead corrosion" is used, it refers to the corrosion of lead plumbing materials that result in the transfer of dissolved or particulate lead into the drinking water.

The Lead and Copper Rule (LCR) sampling is intended to measure the lead levels in drinking water to assess the effectiveness of corrosion control treatment utilized by public water systems (PWSs) to minimize lead in drinking water. PWSs are required to use sampling sites that are presumed to be the highest-risk sites for lead release, and to optimize corrosion control to minimize lead levels at consumers' taps. Most published sampling studies typically focus on systems having high lead levels or systems that have experienced challenges in attempting to balance LCR compliance with various other treatment or water quality objectives. Except for LCR compliance data, little published data exists or is available for systems that are considered to be operating with optimal corrosion control and meeting the lead action level (AL) in the LCR. This study focuses on a system that is considered to have optimized corrosion control using a blended phosphate, with a relatively stable water quality, and compliance results historically well below the lead AL. This situation is representative of a large percentage of systems serving 100,000 or more people that utilize orthophosphate or blended phosphates for corrosion control and the vast majority of systems are meeting the lead AL based on the current sampling protocol in the LCR. Additional information on the LCR and study is available in the Supporting Information (SI). This study focused on whether (1) the current LCR compliance sampling protocol adequately captures the peak lead levels in a water system; (2) "preflushing" (PF) results in capturing lower lead levels in samples compared to samples collected under normal household usage (NHU) conditions; (3) a first-draw sampling protocol appropriately determines the adequacy of optimal lead corrosion control in water systems with LSLs; and (4) there is seasonal variability in the sampling results using the different sampling protocols.

**System Information.** The Chicago Department of Water Management (CDWM) operates two similar conventional surface water filtration treatment plants serving approximately 5.4 million residents, including those in 125 suburbs. Lake Michigan is the sole water source, with relatively stable water quality leaving the treatment plants and in the distribution system (Table 1). Before the LCR, CDWM utilized pH/alkalinity adjustment for corrosion control. CDWM switched to a proprietary blended phosphate at both plants between 1993 and 1994 which is still used as the primary corrosion control treatment.

The LCR requires public water systems to collect lead samples using a first-draw (FD) sampling protocol, and samples were collected almost exclusively from single-family homes with LSLs as required by the LCR sample site selection require-

Received: January 23, 2013 Revised: June 24, 2013 Accepted: July 23, 2013



Table 1. Water Quality Data 2011

		lets	distribution				
parameter	min	max	min	max			
temp (°C)	4	24	5	23			
turbidity (NTU)	0.1	0.2	0.1	0.4			
pH	7.5	7.8	7.7	7.8			
$\operatorname{Cl}_2$ residual (mg/L)	1.0	1.2	0.7	0.9			
total alkalinity (mg/L as CaCO <sub>3</sub> )	103	108	98	108			
chloride (Cl, mg/L)	16	20	17	20			
sulfate (mg/L)	29	31	29	30			
Ca (mg/L)	34	39	34	39			
$PO_4 (mg/L)$	0.4	0.6	0.5	0.5			
total PO <sub>4</sub> (mg/L)	0.8	1.1	0.8	1.2			
Al (μg/L)	34	126	29	113			
Fe $(\mu g/L)$	<5	<5	<5	34			
Mn $(\mu g/L)$	<3	<3	<3	<3			

ments.<sup>3</sup> Since the initial LCR monitoring, Chicago has exceeded the lead AL only once, during July–December 1992, with an average 90th percentile compliance monitoring value between 1999 and 2010 of 6  $\mu$ g/L (SI Table S2).<sup>3</sup>

The LCR requires 1-L, FD tap samples of water that has stood motionless in the plumbing system (i.e., has stagnated within the plumbing) for at least 6 h. The two variants of the FD sampling protocol currently used by public water systems are defined herein as the NHU first-draw sample, where water is used in a normal household manner, and then allowed to sit motionless in the plumbing for at least 6 h before the sample is collected; and the PF first-draw sample, where the water is run from the sampling tap for a specified amount of time immediately prior to the stagnation period. However, the LCR does not provide specific details on water use during the stagnation period.

Almost all PWSs in the U.S. rely on residents to collect compliance samples under the LCR and there are differences across the U.S. in how systems instruct residents not to use the water during the stagnation period prior to collecting the sample. A review of example sets of sampling instructions provided to residents by large PWSs in the U.S. found that some are instructed not to use any water from the tap to be sampled during the stagnation period. Others are instructed not to use any water in the household. Prior to 2009, CDWM used the PF first-draw sampling protocol, with a 5-min preflush preceding stagnation. Recent instructions to residents included not using water from the sampling tap or from any nearby tap until the (poststagnation) samples were collected, and to collect samples as soon as possible after the minimum required 6-h stagnation period. Regardless of the sampling protocol, resident-collected samples necessitate the use of simple instructions and make it difficult to ensure strict adherence to any sampling protocol. In addition, the diverse premise plumbing materials and configurations (SI Table S1) represent varying effects of flow rates, hydraulic flow characteristics, and possible lead sorption/particle release effects on the shapes of the lead profiles, particularly with corroded galvanized pipe locations.4,5

#### MATERIALS AND METHODS

**Sampling Objectives and Protocol.** Since the promulgation of the LCR, new research on lead corrosion has shown that there are many mechanisms and water quality factors

involved. $^{1,4,6-11}$  Specifically, the sampling protocols used in this study were evaluated to determine if

- preflushing biases results;
- first-draw samples, with or without preflushing, capture the "worst-case" level of lead corrosion under normal use conditions; and
- seasonal variability affects lead concentrations (in this water system).

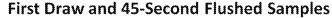
Consistent with the LCR requirements and CDWM compliance sampling, samples for this study were collected by volunteer residents from 32 single-family residences, built between 1890 and 1960, with LSLs. An additional 5 homes were sampled and determined not to have LSLs, and were therefore excluded from further sampling. All results are included in the Supporting Information, but the non-LSL sites were not used in the data analysis (SI Tables S4a, S5, S6a, S6b, and S7).

Information was requested on the specific plumbing configurations of each sampling site to a much greater extent than the regulatory requirements which simply require the plumbing material to be identified. This information, along with analyses conducted for lead, copper, iron, and zinc for each sample, facilitated a better understanding of the observed water lead levels. Residents were asked to (1) complete a plumbing profile identifying the kitchen tap and meter or internal shut-off valve, and (2) describe the internal plumbing, including any recent plumbing work (SI Figure S1). The information provided by residents along with the results of the four metals provided additional information on the sequences of plumbing materials, and the presence of in-line brass plumbing components. CDWM provided the locations of water mains, service line materials, work conducted by the city at each residence (meter installation or repair, shut-off valve repair/ replacement, service line leak repair, street excavation), and monthly water use data for residences with water meters. The information provided by CDWM on water main locations was used to measure the distance from the water main to each residence, and internal plumbing information provided by residents was used along with the measured length from the water main to the residence to approximate the LSL length (SI Table S1).

Residents were provided with written sampling and reporting instructions for each sampling event (SI Figures S41–S45). One-liter, high-density polyethylene (HDPE), wide-mouth (5.5 cm, 2.2 in.) sample bottles were used to collect all samples. Residents were instructed not to remove aerators prior to sampling and not to collect samples after point-of-use or point-of-entry treatment devices.

Several prior studies have suggested that significant contributions of particulate-associated lead can be mobilized as a function of flow rate and turbulence in certain water chemistries, though studies have not developed predictive relationships to premise plumbing material, scale composition, and hydraulic flow characteristics. To try to achieve the most aggressive high flow conditions under realistic field conditions, residents were instructed to collect all samples by slowly opening the cold water kitchen tap until fully open. Upon receipt, the samples were inspected by EPA for visible particulate matter prior to delivery to the laboratory.

For all first-draw samples, residents were instructed not to use any water throughout the household (i.e., no showering, washing clothes/dishes, flushing toilets, etc.) during the



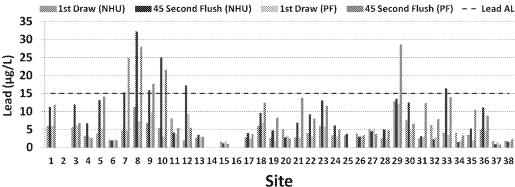


Figure 1. First round lead results for all sites.

minimum mandatory 6-h stagnation period. In this study, PF samples include a flush of at least 5 min prior to the mandatory minimum 6-h stagnation period. A NHU sample had no preflushing prior to the mandatory minimum stagnation period. Residents were instructed to allow the water to sit motionless in the household plumbing a minimum of 6 h, but not more than 24 h, and to record the dates/times the taps were flushed prior to the stagnation period, and the dates/times samples were collected following the stagnation period. First-draw samples using both variants (NHU and PF) were collected in the first and third rounds of monitoring in March/April and September/October, respectively. Additionally, 45-s flushed samples were collected in the first round to evaluate whether a second-draw sample more accurately captured the level of corrosion. Three-min, 5-min, and 7-min flushed samples were collected in the third round of sampling to provide guidance to volunteers when high lead levels were found (SI Table S7). This information can also be used to provide site-specific guidance on minimum flushing times necessary to reduce consumer exposure to lead in drinking water.

In the first round of sampling, each resident collected a NHU first-draw sample and then a second-draw (45-s flushed) sample after allowing the water to run for 45 s. On the second day, residents collected a PF first-draw sample and then a second 45-s flushed sample. EPA's current Public Notification Handbook advises<sup>16</sup> residents to run the water 30 s or until it turns cold before consuming, if the water has not been used for an unspecified "extended period of time", which can result in higher lead levels at the tap for consumers. It has also been previously demonstrated that in some situations, this advice can cause residents to consume the worst-case water sitting stagnant in the LSL.<sup>17</sup> (Figure 1)

Sites 14, 15, 16, and 37 were verified as not having LSLs and were excluded from further sampling. Site 2 was verified as not having a LSL following the June sequential sampling and was excluded from the final round of monitoring. The 45-s flushed sampling was discontinued following the March/April sampling first round due to the presence of severely corroded galvanized pipe in some of the residences (SI Figure S4) which reduced the inner pipe diameter, restricting water flow and resulting in varying volumes of water flowing through the plumbing for the same flush time.

In June 2011, each resident collected a total of twelve PF sequential samples in one day of sampling. The first PF sequential sample was also the PF first-draw sample for the data analysis. All samples were analyzed for lead, copper, zinc, and

iron. The co-occurrence of the metals, along with plumbing details, was used in qualitative assessments to correlate lead results with potential sources of lead in the plumbing network (SI Figure S6). $^{4,10}$ 

In September/October 2011, each resident collected a NHU first-draw sample, and a minimum of 11 PF sequential 1-L samples. Sites with high lead levels in the previous rounds collected an additional 3 or 4 PF sequential samples, and one site with a very long LSL (159 ft, 48 m) collected an additional 9 PF sequential samples. The additional PF sequential samples were collected to determine the point at which lead levels consistently dropped below the AL. All samples collected are included in the sampling summary with the numbers and types of samples collected at each site (SI Table S3).

Most stagnation times were relatively consistent across most sites at between 6 and 8.5 h, and all but two sites had stagnation times between 6 and 9 h 10 min, which facilitated unadjusted comparisons (SI Table S6c).

Additional flushed samples were collected in September/ October for high lead sites in order to provide residents with guidance on minimizing lead levels in their drinking water. Recommended minimum flushing times were then estimated based on the lead levels and LSL lengths. These results are included in the Supporting Information, but not discussed here.

**Sample Analyses.** All samples were visually inspected for particulate matter prior to delivery to the EPA Chicago Regional Laboratory. Samples were preserved upon receipt by the laboratory using concentrated nitric acid to pH <2 and held for a minimum of 24 h prior to analysis. The laboratory's Reporting Limits (RL) for lead, copper, and zinc in drinking water samples, using EPA Method 200.8, are 0.5, 1, and  $10~\mu g/L$ , respectively. The laboratory's RL for iron in drinking water samples, using EPA Method 200.7, is  $80~\mu g/L$ . Additional laboratory information is included in the Supporting Information.

#### RESULTS AND DISCUSSION

Both Variants of the First-Draw Protocol Significantly Underestimated Peak Lead Levels, and the NHU First-Draw Protocol Yielded Higher Results Overall than the PF First-Draw Protocol. The 90th percentile lead values for all three rounds of first-draw sampling using both variants were slightly higher than Chicago's historical compliance results, but still fell well below the lead AL (SI Table S4b). Only 2% of the total number of first-draw samples (3 of 151) exceeded the AL despite the presence of lead levels well above the lead action

#### Comparison of System 90th Percentile Compliance Data with Sequential Sampling 90th Percentile and Maximum Values

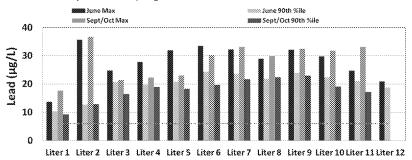
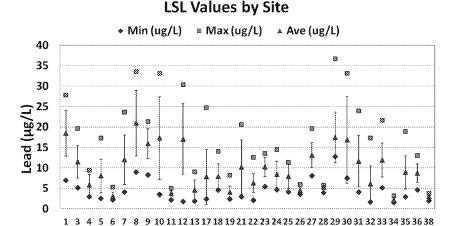


Figure 2. Comparison of 90th percentile LCR compliance data to 90th percentile values from LSL samples (across sites by liter) and maximum values from LSLs. The green dashed line indicates the average 90th percentile compliance monitoring value for Chicago between 1999 and 2010 of 6  $\mu$ g/L.



Site

Figure 3. LSL results were highly variable within each LSL and from site to site. Error bars represent 1 standard deviation.

level within the service lines as indicated by the 45-s flushed results in the first round of monitoring and sequential sampling results in the second and third rounds.

In contrast, if the 90th percentile value of each of the successive sequential liter samples from the LSLs is computed across all sampling sites, the lead levels were up to four times higher than Chicago's average 90th percentile value using FD samples. Some peak values for each sequential liter calculated across all sampling sites were over twice the lead AL and up to six times higher than the regulatory compliance data (Figure 2). In summary, 69 of 336 (21%) of the individual sequential samples collected in June and 75 of 319 (24%) of sequential samples in September/October exceeded the lead AL, indicating that current sampling protocols will often considerably underestimate the peak lead levels and overall mobilized mass of waterborne lead in a system with lead service lines.

The NHU results were numerically higher overall than the corresponding PF values for most sites, but the differences were not statistically significant. The PF first-draw protocol produced lower individual results than NHU first-draw protocol in 23 of 32 sample pairs in March/April, and 20 of 27 sample pairs in Sept/Oct (SI Table S4a). Although NHU first-draw samples were collected without directing the residents to flush the tap prior to the stagnation period, NHU can involve showering, washing dishes, or doing laundry a short time prior to the stagnation period, which could clear the lead from the pipes

similar to preflushing the tap. Thus a NHU sample can be effectively the same as a PF sample and yield similar results. Since the sequential sampling results from these same sites show that there is much higher lead present within the LSL at the same time that the NHU and PF first-draw samples were collected, it stands to reason that if the NHU activities were not undertaken, and a larger sample set were used, the NHU samples would yield results that were statistically higher than the corresponding PF samples. The distance from the kitchen tap to the beginning of the LSL was highly variable, ranging from approximately 3 to 87 feet (0.9 to 27 m), and the measured LSL lengths ranged from 43 to 159 feet (13 to 48 m). Consequently, for sites with shorter total plumbing lengths, the initial and final sequential samples would include relatively uncontaminated water from the water main following the 5-min tap preflushing. These samples would contain little to no LSL lead contribution, consistent with plumbosolvency and radial diffusion/flow principles. 5,19,20 A targeted LSL sampling protocol isolating only LSL contact water would likely yield a higher percentage of results above the lead AL for systems with Pb(II) pipe scale chemistry, but the specific location of the peak lead levels will necessarily vary with premise plumbing configurations.

**Seasonal Variability.** In a site-by-site comparison, lead concentrations were higher in Sept/Oct than in Mar/Apr or June, with the starkest statistical difference between first-draw

# Disturbed and Undisturbed Average LSL Values

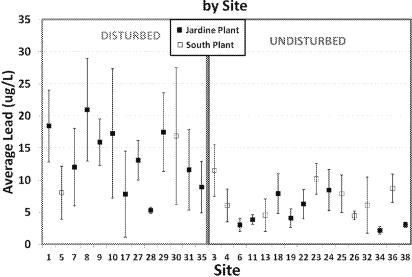


Figure 4. Average lead levels at disturbed and undisturbed sites. Error bars represent 1 standard deviation.

NHU samples collected in Mar/April and Sept/Oct (p=0.03 for two-tailed paired Student's t-test). Overall, 68% and 69% of NHU and PF first-draw samples, respectively, were higher in Sept/Oct than in Mar/Apr, while 55% of paired sequential samples were higher in Sept/Oct than in June. Seasonal variation in lead levels consists of multiple contributing factors from the source water through the premise plumbing which could not be precisely isolated in this study, but the results in this study are consistent with other findings on seasonal variability (SI Table S6d). Factors include (1) water temperature, (2) water chemistry variation, and (3) fluctuations in water usage for Sept/Oct versus June, which could increase or decrease lead levels.  $^{22,23}$ 

Lead Concentrations Vary Throughout Each Individual LSL and among Different LSLs Across the System. There was a high degree of variability in sequential sample results at most sites, some of which could include a particulatebound component as reflected in spikes in some sequential sampling results (SI Figures S9-S40). For most sites, no individual sample result from within the LSL can characterize the lead concentrations at the site. Within the complete sampling profile results, lead levels at most sites ranged from well below to well above the AL (Figure 3). Under the LCR, this would mean that a system would meet the action level and have no additional regulatory requirements or would exceed the AL and be required to implement additional requirements, depending on which sample result is selected as the compliance sample. The variability within sites and between sites is similar in trend to that found in several other studies reporting sequential sampling conducted in water systems with different corrosion control strategies and chemistries from CDWM. 1,4,10,12,14,15,24-27

Additional compliance data from a second large utility (City B) which exceeded the lead AL and conducted sampling using the temperature change LSL sampling protocol in the LCR, yielded similar variability across the system (SI Figure S8 and Table S9). A total of 1975 LSL sites were sampled, with 1762 results (89%) below the lead AL; 128 results (6.5%) from 16 to 30  $\mu$ g/L; 57 results (2.8%) from 31 to 50  $\mu$ g/L; and 28 results (1.4%) between 51 and 580  $\mu$ g/L. This LSL sampling protocol

is similarly vulnerable to low biases, although many results were considerably higher than the AL (SI Figure S8).

Factors Affecting Lead Levels. The majority of high lead results occurred at sites with a documented physical disturbance of the LSL between 2005 and 2011 (Figure 4). The actual extent to which the LSL was physically disturbed is unknown for all sites, and the records of disturbances are based on information provided by CDWM and by the sampling volunteers (SI Figures S9–S40).

For the purpose of this study a physical LSL disturbance is defined as a meter installation or replacement, autometer-reader (AMR) installation, service line leak repair, external service shut-off valve repair or replacement, or significant street excavation directly in front of the home that could disturb the LSL. An "undisturbed" site is an unmetered site where neither the CDWM nor resident have a record or recollection of any disturbance, as defined above. A third category, "indeterminate", is used for three sites where CDWM has no record of any LSL disturbance, and the resident did not provide a response as to whether there has been any LSL disturbance. Cross-checking was important because information provided by volunteers in some cases contradicted CDWM records, and upon further investigation, the records were found to be incomplete and were corrected, which resulted in reclassification of the site.

Of the 13 disturbed sites, 11 sites had 3 or more sequential sampling results above the lead AL, two sites had 2 results each above the AL, and one site had no results above the AL. Of the 16 sites with no known disturbance, only three sites had any results above the lead AL. In the remaining 3 "indeterminate" sites, 30 of 81 sample results (37%) were above EPA's lead AL (Table 2).

A recent AWWA publication on the state of water infrastructure highlights the need for major infrastructure work. This necessary infrastructure work will potentially increase the incidence of damage to the protective scales within LSLs as this work is performed. Inevitably, these physical LSL disturbances will continue to occur with increased frequency as part of daily routine water system maintenance and nonwater related community infrastructure work.

Table 2. Lead Results for Disturbed, Undisturbed, and Indeterminate  $Sites^a$ 

,	disturbed s	ites	uı	ndisturbed	sites	inc	leterminate	sites
no. sites	no. samples	no. above AL	no.	no. samples	no. above AL	no.	no. samples	no. above AL
13	327	117	16	372	6	3	81	30
% s	amples ov 36%	er AL:	% sar	nples over	AL: 2%	% s	amples ov 37%	er AL:

"Most lead results above the AL were found at sites with LSL disturbances. Additional results above the AL were also found at sites where the status of the LSL (disturbed or undisturbed) could not be confirmed. Sites without LSL disturbances had few if any results above the AL.

#### Possible Implications of Water Conservation and Use.

Information provided by CDWM and volunteers anecdotally suggests that low water usage may also play a role in high lead levels at some sites. Of the four locations with the highest average lead levels, three (Sites 1, 29, and 10) had documented low water usage. Site 1 had average monthly water usage of 3444 gallons (13 037 L) which does not appear to be low usage. However, information provided by the resident indicates that the majority of the monthly water usage occurs during a relatively small number of days during the month when there is a high volume of water usage. Site 29 had average monthly usage of 1826 gallons (6912 L), and Site 10 had an average usage of 1438 gallons/month (5443 L/month). For comparison, the mean single-family household water usage is approximately 8582 gallons/month (32 486 L/month), with a sizable standard deviation.

In two locations (Sites 17 and 5), lead levels decreased with an increase in water usage. As water usage approximately doubled at Sites 17 and 5, maximum lead levels from sequential sampling decreased from 25 to 5.5  $\mu$ g/L and from 17 to 12  $\mu$ g/L, respectively. Although this represents a small set of samples, these observations support the idea that higher lead levels can be associated with low water usage.<sup>30</sup>

Extrapolating from prior research suggests the necessity of consistent flow to deliver corrosion inhibitor effectively into passivating films, <sup>31</sup> and correlates increased inhibitor dosages with reduced lead release. <sup>10,32–35</sup> Low water usage may inhibit healing of the damaged scales, and influence the rate of galvanic corrosion. Water usage effects cannot be separated from other seasonal effects in this study, but prior literature and the combined sequential graphs showing entire profiles shifted up or down from the June to Sept/Oct sampling suggest further investigation is warranted (SI Figures S9–S40). As conservation efforts increase, it will become increasingly important to conduct further research on the relationship between water usage and increases in lead levels.

The results in this study also indicate that more appropriate flushing guidance must be developed, based on neighborhood and premise plumbing characteristics, and whether a home has a LSL or not. Much of the current published and web-based flushing guidance inadvertently increases the risk of exposure to elevated lead levels by clearing an insufficient amount of water volume. Even fully flushing LSLs may only lower lead levels to a limiting, measurable lead level, that relates to the plumbosolvency of the water, the flow rate, the length and internal diameter of the pipe, 5-7,10,19,20 and possibly effects of prior disturbances (SI Table S7).

Risk Identification and Management. Recently, CDC issued a health alert associating higher elevated blood lead levels with partial LSL replacement,<sup>36</sup> and also concluded that LSLs were an independent risk factor for elevated blood lead levels even when lead levels in drinking water met the LCR lead AL of 0.015 mg/L.<sup>37</sup> As highlighted in this study, LSLs can contribute high lead when they are disturbed in many different ways, not just due to partial LSL replacement, and water usage may also play a role in the resultant high lead levels and potential increased human exposure. In an August 2012 update on lead in drinking water and blood lead levels, the CDC notes that "The recent recommendations from the CDC Advisory Committee on Childhood Lead Poisoning Prevention to reduce or eliminate lead sources for children before they are exposed underscore the need to reduce lead concentrations in drinking water as much as possible".<sup>38</sup>

As the ultimate human and environmental health goal, LSLs should be completely removed where possible. The stability of the protective scales within LSLs depends on many factors which can change over time. For example, changes to water quality or treatment have resulted in high lead levels over a sustained period of time (years). Under the current regulatory framework, elevated lead levels from disturbances, water quality, treatment, or water usage changes can potentially go undetected for up to 3 years between LCR compliance monitoring periods, which can result in increased public exposure over a significant period of time.

Proper selection of sampling sites, sampling protocol, and other site conditions is critical for evaluating the amount of lead corrosion and release that is occurring in the distribution system. Successful optimization of the plumbosolvency treatment depends on an accurate understanding of the corrosion mechanisms, pipe scale mineralogy and structure, and the consequences of LSL disturbances and water conservation efforts. No published studies could be found that systematically investigated the time and inhibitor doses/water quality adjustments necessary to overcome the disturbances and damage to the lead pipe scales that will be routinely occurring throughout cities across the U.S., as long as full or partial lead service lines remain in service.

Analyses of the Chicago LSL scales by EPA (to be reported elsewhere) reveal that the surface coatings on both lead service line and galvanized interior pipes from CDWM are primarily composed of amorphous aluminum, calcium, and phosphorus-rich deposits, and not crystalline lead(II) (or zinc)-orthophosphate phases that are predicted by conventional divalent lead plumbosolvency theory for orthophosphate dosing. 10,33,42 An understanding of the scales is essential to study and implement procedures and strategies for effective and timely repair of the protective scales damaged by LSL disturbances, and to minimize the public's exposure to high lead levels that can result from damaging the scales. Experimental evaluations are critical when scale compositions fall outside the scope of well-understood predictive corrosion control practices.

#### ASSOCIATED CONTENT

### Supporting Information

Additional background information, tabular summaries of sampling results, and graphics. This material is available free of charge via the Internet at http://pubs.acs.org.

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#### Notes

The authors declare no competing financial interest.

#### ACKNOWLEDGMENTS

We wish to express special thanks to the City of Chicago Department of Water Management for the considerable time and effort put forth in providing information for this project, and to the EPA and HUD volunteers who participated in this study and opened up their homes to make this project possible, as well as the team at the EPA Chicago Regional Laboratory for their work on the sample analyses, and Mostafa Noureldin (EPA) and Kevin Sui (Northwestern University) for their valuable assistance during this project. Any opinions expressed in this paper are those of the authors and do not necessarily reflect the official positions and policies of the EPA.

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# Detection and Evaluation of Elevated Lead Release from Service Lines: A Field Study

(Supporting Information for Manuscript ID: es-2013-003636)

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The supporting information provides additional background information, summaries and graphics for the underlying data used in the study.

	Summary of Supplemental Figures and Tables											
Figures		Tables										
Figure S1	Plumbing Profile Diagram	Table S1	LSL Lengths									
Figure S2	Photograph of LSL Bulb	Table S2	Chicago Compliance Data									
Figure S3	Photograph of LSL Segment	Table S3	Summary of Samples Collected									
Figure S4	Photograph of Corroded Galvanized Pipe	Table S4a	First-draw and Second-draw (45 second flushed) Sample Results									
Figure S5	Sample Site Map and Home Age	Table S4b	Comparison of LCR-equivalent 90 <sup>th</sup> percentile results using alternative first-draw protocols.									
Figure S6	Graph of Four Metals for Site 9	Table S5	June Sequential Sampling Results									
Figure S7	City B Sampling Instructions	Table S6a	Sept/Oct Sequential Sampling Results Used in Analyses									
Figure S8	City B LSL Results	Table S6b	Sept/Oct Supplemental Sequential Sampling Results (Not Used in Analyses)									
Figure S9-S40	Sequential Sampling Graphs (Lead)	Table S6c	Summary of stagnation times.									
Figure S41	Mar/Apr Sampling Instructions	Table S6d	Seasonal variability effects observed									
Figure S42	Mar/Apr Sample Collection and Reporting Form	Table S7	Flushed Sampling Results									
Figure S43	June Sampling Instructions and Sample Collection and Reporting Form	Table S8	Summary of Disturbed, Undisturbed and Indeterminate Sites									
Figure S44	Sept/Oct Sampling Instructions	Table S9	City B Compliance Data									
Figure S45	Sept/Oct Sample Collection and Reporting Form											

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#### **Background**

The Lead and Copper Rule (LCR) is a treatment technique regulation that requires all public water systems to optimize corrosion control and utilizes tap sampling for lead and copper to determine whether additional actions need to be taken by the system. It is important to note that the sampling conducted under the LCR is not designed to evaluate individual consumers' lead exposure or risk and that the lead action level (AL) was not established as a health-based number. The lead AL is the level which EPA determined in 1991 that systems could feasibly meet, taking into account the available treatment technologies and the cost of those treatment technologies. The lead AL should not be viewed or used as a threshold value to determine whether the water is safe or unsafe to drink, and it should be reiterated that the EPA and CDC have determined that there is no safe level of lead exposure (i.e., no level at which there is not an adverse effect).

Tap sampling conducted under the LCR is intended to measure the amount of lead and copper corrosion that is occurring in public water systems using worst-case site selection and a specified sampling protocol. The sampling protocols in the current LCR were established in 1991, based on the existence of many potential sources of lead throughout the water distribution system, including lead service lines connecting the water main to the homes, leaded-solder used to join copper pipe, and leaded-brass devices, such as meters, brass connectors and shut-off valves, faucets and fixtures. The current LCR sampling requirements are prescriptive and based on the relative significance of lead sources in 1991. The sequential sampling protocol (described below, and in the accompanying paper) that resulted in capturing the highest lead, as well as the sample results themselves, are not allowed to be used in the current compliance calculation.

The LCR utilizes a combination of: worst-case site selection (sites expected to yield the highest lead results); sampling protocols used to capture the highest lead; and repeated sampling at the same sites in order to measure the level of lead corrosion that is occurring throughout the water distribution system. Utilizing this sampling structure allows U.S. EPA to keep the sampling burden on public water systems manageable, while still accomplishing the objectives of the sampling under the LCR. Absent these key components, the number of samples needed to accurately assess system-wide corrosion would necessarily need to increase substantially to accomplish the objectives of the LCR.

The action level for lead is 0.015 mg/L, but is presented here as 15 µg/L for the purpose of using consistent units for the data. An exceedance of the lead AL based on the sampling triggers specific actions that a public water system must undertake to protect public health, such as installing or adjusting corrosion control treatment and providing public education. Additionally, where the corrosion control treatment has proven ineffective at lowering lead levels below the lead AL, the removal of lead service lines is triggered. There are many different corrosion mechanisms and factors that govern lead corrosion. The selection of sampling sites, sampling protocol, and site conditions are essential components for evaluating the level of corrosion that is occurring in the distribution system, regardless of the mechanism(s) or contributing factor(s). It is therefore critically important that the sampling protocol accurately portray the level of corrosion that is occurring.

### **Lead Service Line and Plumbing Information**

As part of the sampling protocol, residents were asked to provide a plumbing profile (figure S1), describing their internal plumbing, and identifying the location of the kitchen tap, and shut-off valve/meter.

		þ																													

#### **Home Plumbing and Service Line Diagrams**

Below there are 4 diagrams for common household plumbing configurations and the 5<sup>th</sup> diagram is blank. Please review the diagrams and select the diagram that best matches the plumbing configuration for your home. Each of the diagrams shows where the water service line comes into the home and where the kitchen tap is located. If none of the four diagrams matches your home, use the blank diagram (number 5) to draw where the water service line comes into your home and where your kitchen tap is located. If you do not know where the service line comes into the home, you can note that in your Home Plumbing description below.

**Note:** Some homes have water meters and some do not. On the diagrams below, if you do not have a water meter, pick the diagram that matches where your service line comes into your home and where the kitchen tap is, and cross out the meter symbol

<u>Home Plumbing Description:</u> In the space below, please describe your home plumbing as best you can, from the point at which the water service line comes into your home to the location of your kitchen tap (length of pipe, diameter of pipe, pipe material, etc.):

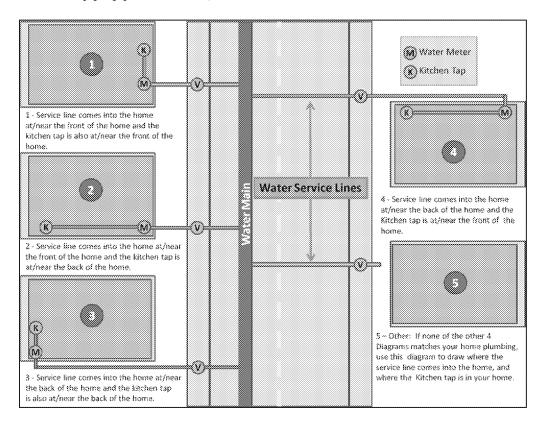


Figure S1: Plumbing Profile Diagram

Table S1 contains a summary of the LSL information for each sampling site. Due to the site-specific plumbing characteristics, the liter which first begins to capture LSL water at each site was expected to be variable, as was the liter which would begin to collect uncontaminated water from the water mains. The study findings regarding whether the current sampling protocol is capturing the corrosion that is occurring are not affected by this limitation.

Site	LSL Length ft (meters)	LSL End Point	Site	LSL Length ft (meters)	LSL End Point
1	89 (27.1)	BFW	22	65 (19.8)	IFW
3	73 (22.3)	IFW	23	66 (20.1)	IFW
4	Unknown	Unknown	24	56 (17.1)	IFW
5	80 (24.4)	IBW	25	70 (21.3)	IFW
6	60 (18.3)	IFW	26	66 (20.1)	IFW
7	59+ (18.0+)	BFW	27	47+ (14.3+)	Unknown
8	57 (17.4)	IFW	28	61+ (18.6+)	Unknown
9	102 (31.1)	BFW	29	159 (48.5)	BFW
10	48+ (14.6+)	IFW	30	49+ (14.9+)	Unknown
11	50 (15.2)	IFW	31	71+ (21.6+)	IFW
12	53 (16.2)	IFW	32	43 (13.1)	IFW
13	49+ (14.9+)	Unknown	33	43+ (13.1+)	IFW
17	58+ (17.7+)	Unknown	34	Unknown	Unknown
18	76 (23.2)	IFW	35	80 (24.4)	BFW
19	63(19.2)	IFW	36	110 (33.5)	IBW
21	46 (14.0)	IFW	38	51 (15.5)	IFW

IFW = LSL ends just inside the front wall

IBW = LSL ends just inside the back wall

BFW = LSL ends at an unknown distance beyond the front wall

**Table S1:** LSL Lengths – The length of the LSLs for most sites were measured and are presented in this table. The LSLs for two sites (site 4 and site 34) were not measured.

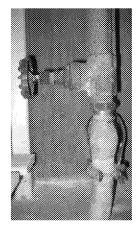


Figure S2: LSL Bulb

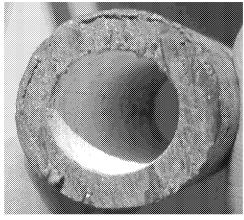
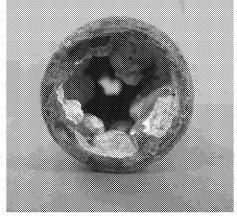


Figure S3: LSL segment (3/4 inch / 1.91 cm diameter)



**Figure S4:** Severely corroded galvanized iron pipe.

<sup>+=</sup> Indicates that the LSL was measured from the water main to the front the home, and it is not known whether the LSL extends beyond the front wall of the home.

Figure S2 shows a typical LSL in Chicago coming up from the foundation of the basement. The lead service line is a dull gray and easily scratched with a key. The soft LSL is typically soldered to the interior (household) plumbing, leaving a characteristic bulb. The LSL can also be connected to household pipe using a brass compression fitting.

Figure S3 is a close-up of a 3/4 inch (1.91 cm) diameter LSL, showing the thickness of a typical LSL.

Figure S4 is a cross-section of a severely corroded galvanized pipe from one of the sample sites. In this photograph the inner diameter is significantly reduced which affects the volume of water that will flow through the pipe in a set amount of time. For homes with corroded galvanized pipe, water will flow slower through the pipe and longer flushing times are generally needed to flush the lead from the plumbing.

# **City Information**

Samples were collected from 32 single-family homes in Chicago with LSLs. Twenty-three homes were in the Jardine Plant service area and nine homes were in the South Plant service area.

Site #	Home Built	Service Area
01	1893	Jardine
03	1960	Jardine
04	1941	South
05	1901	South
06	1953	Jardine
07	1900	Jardine
-08	1941	Jardine
09	1920	Jardine
10	1943	Jardine
11	1912	Jardine
12	1952	Jardine
13	1950	South
17	1907	Jardine
18	1953	Jardine
19	1912	Jardine
21	1938	Jardine
22	1924	Jardine
23	1944	South
24	1906	Jardine
25	1917	South
26	1954	South
27	1891	Jardine
28	1932	Jardine
29	1890	Jardine
30	1954	South
31	1923	Jardine
32	1923	South
33	1927	Jardine
34	1915	Jardine
35	1900	Jardine
36	1957	South
38	1927	Jardine

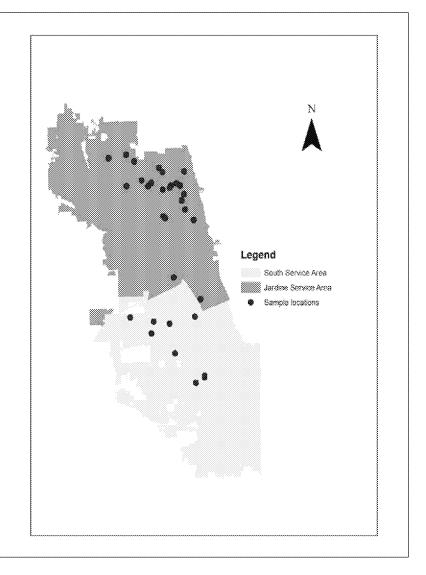


Figure S5: Home age and plant service areas for sampling locations

Table S2 contains a summary of the City's compliance monitoring data for lead. The City exceeded the lead AL only once, during the July-December 1992 compliance monitoring period.

City of Chicago (1992 – 2010) 90 <sup>th</sup> Percentile Lead Values (μg/L)											
Monitoring Period Begin	Monitoring Period End	Number of Samples	90th Percentile Value								
1/1/2008	12/31/2010	50	6								
1/1/2005	12/31/2007	50	6								
1/1/2002	12/31/2004	50	4								
1/1/1999	12/31/2001	50	7								
1/1/1999	12/31/1999	50	8								
1/1/1998	12/31/1998	53	14								
7/1/1997	12/31/1997	100	11								
1/1/1997	6/30/1997	100	10								
1/1/1993	6/30/1993	100	13								
7/1/1992	12/31/1992	120	20								
1/1/1992	6/30/1992	100	10								

**Table S2:** City of Chicago 90<sup>th</sup> Percentile Compliance Values (1992 – 2010)

## **Laboratory and Analytical Information**

All samples were inspected for visible particulates prior to delivery to the laboratory. In light of the significant increase in visible particulate in the final round of monitoring, the presence of fine particulates that would readily dissolve in the nitric acid preservative should not be discounted. Samples collected during the final round of monitoring coincided with the Fire Department's annual valve exercising. Colloidal lead may explain some of the variability in lead levels between the June and Sept/Oct rounds.

Laboratory blanks, laboratory fortified blanks and laboratory fortified samples were run at a frequency of at least one per twenty samples. Laboratory blanks run with the samples did not have any detections of lead above the reporting limit and all Laboratory fortified blanks and laboratory fortified samples had recoveries greater than 90%.

All laboratory instrumentation was inspected and maintained according to Chicago Regional Laboratory maintenance protocols, and calibrated daily according to Chicago Regional Laboratory standard operating procedures.

The Chicago Regional Lab Quality Assurance (QA) Contact performed a data quality assessment on the results based on laboratory blanks, laboratory fortified blanks and matrix spikes. The QA Contact identified no biases in the sample results due to these quality control measurements.

# **Sampling Summaries**

**Sample site summary table** - A summary table of the types of samples collected at each site, for each sampling protocol is presented in Table S3 below. The highlighted rows for Sites 2,

14, 15, 16 & 37 were confirmed not to have LSLs and Site 20 is the same residence as Site 21 (Kitchen tap and bathroom tap). Following the first round of sampling, Site 20 (bathroom tap) was no longer sampled, to maintain consistency of using kitchen taps across all sites. Only sample results from LSL sites are presented and analyzed in the study paper. The first liter of the sequential samples in June and Sept/Oct also serve as the PF first-draw samples.

	Summary of Samples Collected at Each Site													
C:4- #	Total #	Mar/	April	June		Sept/Oct								
Site #	Samples	Day 1	Day 2	Day 1	Day 1	Day 2	Day 3							
01	34	A, C	B, D	E-12 samples	A	E-14 samples	F, G, H							
02	16	A, C	B, D	E-12 samples	DNS	DNS	DNS							
03	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
04	16	A, C	B, D	E-11 samples	DNS	DNS	DNS							
05	28	A, C	B, D	E-12 samples	A	E-11 samples	DNS							
06	28	A, C	B, D	E-12 samples	A	E-11 samples	DNS							
07	35	A, C	B, D	E-12 samples	A	E-15 samples	F, G, H							
08	35	A, C	B, D	E-12 samples	A	E-15 samples	F, G, H							
09	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
10	34	A, C	B, D	E-12 samples	A	E-14 samples	F, G, H							
11	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
12	34	A, C	B, D	E-12 samples	A	E-14 samples	F, G, H							
13	16	A, C	B, D	DNS	A	E-11 samples	DNS							
14	4	A, C	B, D	DNS	DNS	DNS	DNS							
15	4	A, C	B, D	DNS	DNS	DNS	DNS							
16	4	A, C	B, D	DNS	DNS	DNS	DNS							
17	34	A, C	B, D	E-12 samples	A	E-14 samples	F, G, H							
18	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
19	27	A, C	B, D	E-12 samples	DNS	E-11 samples	DNS							
20	4	A, C	B, D	DNS	DNS	DNS	DNS							
21	28	A, C	B, D	E-12 samples	A	E-11 samples	DNS							
22	28	A, C	B, D	E-12 samples	A	E-11 samples	DNS							
23	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
24	33	A, C	B, D	E-12 samples	A	E-14 samples	F, G							
25	16	A, C	B, D	E-12 samples	DNS	DNS	DNS							
26	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
27	33	A, C	B, D	E-12 samples	A	E-14 samples	F, G							
28	30	A, C	B, D	DNS	A	E-11 samples	F, G							
29	40	A, C	B, D	E-12 samples	A	E-20 samples	F, G, I							
30	18	A, C	B, D	DNS	A	E-11 samples	F, G							
31	31	A, C	B, D	E-12 samples	A	E-12 samples	F, G							
32	28	A, C	B, D	E-12 samples	A	E-11 samples	DNS							
33	33	A, C	B, D	E-12 samples	A	E-14 samples	F, G							
34	18	A, C	B, D	DNS	A	E-11 samples	F, G							
35	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
36	30	A, C	B, D	E-12 samples	A	E-11 samples	F, G							
37	4	A, C	B, D	DNS	DNS	DNS	DNS							
38	16	A, C	B, D	E-12 samples F = 3-minute Flush	DNS	DNS	DNS							

A = NHU First-draw Sample

F = 3-minute Flushed Sample

B = PF First-draw Sample

C = NHU 45-Second Flushed Sample

D = PF 45-Second Flushed Sample

E = Sequential Sample

G = 5-minute Flushed Sample

H = 7-minute Flushed Sample

I = 10-minute Flushed Sample DNS = Site did not sample

**Table S3:** Summary of samples collected at each site using each sampling protocol.

*First-draw and 45-second flushed samples* – Results for first-draw and 45-second flushed samples using the normal household use (NHU) and pre-flushed (PF) sampling protocols are presented in Table S4 below.

In addition to the first-draw samples, a 45-second flush sample was collected by running the water for 45 seconds immediately following the collection of the NHU first-draw and PF first-draw samples during the March/April sampling. Overall, the 45-second flush sample results were higher than the first-draw results, and yielded a higher percentage of results above the lead AL. A total of 32 NHU/45-second flushed and 32 PF/45-second flushed samples were collected, with 6 NHU 45-second flushed results above the lead AL (19%), and 5 PF/45-second flushed results above the AL (16%). The total number of 45-second flush sample results above the lead AL was 11 of 64 (17%); a percentage significantly higher than the first-draw results (2%).

6.7	A	C	В	D	В	A	В
Site	(Mar/Apr)	(Mar/Apr)	(Mar/Apr)	(Mar/Apr)	(June)	(Sept/Oct)	(Sept/Oct)
1	5.93	11.3	5.94	11.9	6.98	7.37	9.19
3	5.60	12.0	6.01	6.71	5.82	10.0	8.28
4	3.25	6.76	3.12	2.56	3.61	DNS	DNS
5	3.84	13.2	4.97	14.1	2.56	3.04	2.76
6	2.31	1.90	2.07	2.13	2.50	2.44	2.25
7	4.74	15.3	4.62	24.9	4.91	5.12	4.03
8	11.2	32.2	7.12	28.0	11.1	17.5	9.24
9	6.82	15.9	9.80	17.7	10.4	15.3	8.29
10	5.46	25.0	3.06	21.6	3.70	4.98	3.46
11	8.08	4.13	3.85	5.30	2.15	3.53	2.96
12	1.99	17.2	9.36	5.45	1.80	2.27	5.35
13	2.68	3.50	3.05	2.94	DNS	2.53	1.88
17	2.83	4.00	2.50	3.70	2.37	2.65	2.73
18	5.98	9.57	6.60	12.4	4.55	5.80	4.75
19	2.59	4.69	1.92	8.27	2.90	DNS	3.01
21	2.81	6.87	2.60	13.8	3.16	4.13	2.99
22	3.91	9.19	3.36	7.93	2.06	3.21	2.29
23	5.97	13.1	5.80	11.5	8.30	9.16	7.02
24	3.33	6.10	3.05	4.98	4.63	7.57	6.62
25	3.41	3.75	ND	ND	4.28	DNS	DNS
26	3.89	3.02	3.12	3.45	3.51	4.53	4.88
27	5.19	4.53	5.36	3.76	8.06	8.30	12.6
28	2.51	4.99	2.47	4.70	DNS	4.26	3.94
29	12.8	13.5	12.1	28.6	13.7	1.9	17.6
30	7.56	12.5	4.72	6.52	DNS	8.39	7.88
31	2.53	3.16	2.92	12.3	4.03	4.67	5.97
32	6.18	2.29	2.90	7.82	3.08	3.36	2.94
33	4.25	16.4	3.51	14.0	5.18	5.55	5.52
34	4.12	1.51	1.88	3.30	DNS	2.07	1.52
35	3.53	5.28	2.04	10.5	2.86	5.02	3.44
36	5.11	11.1	4.56	8.76	5.02	5.88	4.61
38	1.87	1.60	1.66	2.30	1.92	DNS	DNS
Ave	4.76	9.23	4.25	9.74	4.82	5.73	5.45
n	32	32	32	32	28	28	29

**Table S4a:** First-Draw and 45-Second Flushed Sampling Results. Samples that were above the lead AL are in bold, and samples that contained visible particulates are shaded yellow.

	Summary of NHU and PF First-Draw Results														
	NHU (Mar/Apr)	PF (Mar/Apr)	PF (June)	NHU (Sept/Oct)	PF (Sept/Oct)										
90th %ile Pb Value (µg/L)	8	7	8	10	9										
No. of Samples	32	32	28	29	30										
No. > AL	0	0	0	2	1										

**Table S4b:** Comparison of LCR-equivalent 90<sup>th</sup> percentile results using alternative first-draw protocols.

Sequential sampling results (June 2011) – The sequential sampling approach provided a more reliable (volumetric) method for assessing corrosion as compared to a flushed (time-based) approach. Attempting to characterize the flow at each site would require an evaluation of the plumbing materials and dimensions, as well as the condition of the plumbing materials at each site, is not a feasible or reliable protocol for compliance monitoring.

The results of the each liter in the sequential sampling conducted in June are tabulated below in Table S5 by site.

	June Sequential Sampling Results by Site/Liter (µg/L)											
						Lit	er					
Site	1	2	3	4	5	6	7	8	9	10	11	12
01	6.98	10.5	24.8	27.8	27.5	24.3	22.6	17.8	19.5	20.0	21.1	19.6
03	5.82	8.91	9.18	10.2	13.1	14.6	14.4	12.9	12.1	11.6	10.7	9.34
04	3.61	5.56		7.17	8.90	9.41	8.78	8.30	5.14	3.59	3.11	2.96
05	2.56	6.73	14.0	17.3	16.5	9.85	6.72	6.29	6.01	5.73	5.65	5.60
06	2.50	2.23	2.28	2.57	2.44	2.75	2.65	2.59	3.57	5.26	4.67	4.80
07	4.91	5.45	6.28	6.73	7.03	22.9	23.6	19.7	16.3	16.2	16.7	14.6
08	11.1	12.8	21.6	19.7	32.0	33.5	32.2	28.9	32.1	29.7	24.2	18.7
09	10.4	18.0	20.8	20.0	17.9	17.0	15.8	14.7	14.3	12.9	11.5	9.48
10	3.70	5.20	5.39	6.49	14.9	23.6	22.4	21.9	23.9	20.2	20.7	20.9
11	2.15	2.58	2.76	2.97	3.36	3.61	3.73	3.82	4.28	4.11	4.11	4.43
12	1.80	2.95	3.55	6.69	20.9	26.9	25.7	25.1	24.9	22.4	15.9	7.80
17	2.37	8.46	7.12	7.20	7.27	10.5	9.91	9.56	22.6	23.3	24.7	6.30
18	4.55	5.73	5.12	6.43	5.41	5.62	5.5	9.38	14.0	12.1	11.3	11.6
19	2.90	2.62	2.41	8.22	4.58	3.16	4.02	5.07	4.57	4.06	3.31	2.82
21	3.16	3.12	3.08	2.97	13.0	20.6	18.7	16.4	16.3	14.2	6.78	3.21
22	2.06	2.82	5.11	5.42	6.89	12.6	7.80	7.11	6.52	6.55	7.55	7.45
23	8.30	9.06	11.1	13.5	13.2	12.4	11.7	11.0	9.55	7.16	5.69	5.41
24	4.63	6.06	6.43	5.24	5.06	4.91	5.02	8.21	11.9	12.6	11.9	12.2
25	4.28	4.28	4.15	4.23	6.82	10.9	11.3	10.9	10.1	9.68	9.17	8.82
26	3.51	3.83	3.99	3.93	3.86	3.99	4.00	4.01	4.12	4.39	4.30	4.23
27	8.06	9.13	9.84	10.3	10.4	11.4	13.10	13.9	14.2	13.3	12.2	10.1
29	13.7	35.7	18.8	17.7	16.8	16.5	16.6	15.7	14.4	14.1	13.7	13.4
31	4.03	5.03	5.14	6.17	13.1	15.4	15.6	16.3	20.8	18.8	7.91	4.48

	June Sequential Sampling Results by Site/Liter (μg/L)											
	Liter											
Site	1	2	3	4	5	6	7	8	9	10	11	12
32	3.08	2.29	2.07	2.28	6.95	15.5	9.91	9.27	8.30	6.12	2.60	1.65
33	5.18	6.85	10.0	7.74	9.61	13.9	16.4	13.5	12.3	13.7	10.7	9.95
35	2.86	7.89	12.9	11.9	9.85	8.59	7.28	6.82	6.23	5.34	5.02	4.83
36	5.02	6.90	7.68	8.46	9.90	9.81	9.51	9.34	9.19	8.93	9.20	9.19
38	1.92	3.04	3.06	3.04	2.91	3.03	3.12	3.07	3.36	3.21	3.04	3.76
Min	1.80	2.23	2.07	2.28	2.44	2.75	2.65	2.59	3.36	3.11	2.60	1.65
Max	13.7	35.7	24.8	27.8	32.0	33.5	32.2	28.9	32.1	29.7	24.7	20.9
Ave	4.83	7.28	8.42	9.07	11.1	13.1	12.4	11.7	12.5	11.7	10.3	8.50
90 <sup>th</sup> %ile	10.4	12.8	20.8	19.7	20.9	24.3	23.6	21.9	23.9	22.4	21.1	18.7

**Table S5:** Summary of June Sequential Sampling Results. Samples that were above the lead AL are in bold, and samples that contained visible particulates are shaded yellow.

Sequential Sampling Results (September and October 2011) – The results of the each liter in the sequential sampling conducted in September and October are tabulated below in Table S6 by site. Considerably more sample results contained visible particulates than in previous rounds. The presence of particulates may be a result of the Chicago Fire Department exercising valves during the time period when samples were being collected.

All sites collected at least 11 sequential samples, and some sites with high sample results in June collected additional samples. The additional sequential sample results are included here but were not included in the data analyses, since extra samples were collected only from sites with high lead. A review of the data, including and excluding these additional results was performed to ensure that a bias has not been introduced, and the review indicates that the study findings are not significantly affected by including or excluding the data. With the additional 39 samples included, a total of 80 of 358 sample results (22%) exceeded the lead AL. Using only samples 1 through 11 from each site, a total of 75 of 319 sample results (24%) exceeded the lead AL. For the purpose of the data analyses, the first liter sample from the sequential samples in June and Sept/Oct also serve as the first-draw PF sample.

		Sei	ot/Oct Se	quential S	Sampling	Results I	oy Site/Lit	er (µg/L	)		
						Liter	•		<u> </u>		
Site	1	2	3	4	5	6	7	8	9	10	11
01	9.19	12.8	21.4	22.3	22.0	19.6	16.5	15.6	14.5	14.2	13.8
03	8.28	5.58	5.17	6.43	8.46	14.9	19.6	16.4	15.4	14.3	17.1
05	2.76	10.8	12.2	10.9	12.3	7.21	5.49	5.24	4.65	5,30	5.40
06	2.25	2.18	3.43	2.37	2.30	2.28	2.81	2.32	2.20	4.16	5.03
07	4.03	4.27	5.74	5.75	9.87	15.1	15.3	15.2	12.1	14.8	13.9
08	9.24	8.95	9.45	11.8	18.3	25.0	22.7	22.3	22.9	19.1	15.8
09	8.29	20.0	18.8	21.3	20.0	17.6	16.3	15.7	14.6	14.8	16.1
10	3.46	6.27	6.23	5.05	14.8	21.4	33.1	29.8	32.4	28.1	27.7
11	2.96	4.05	3.90	3.91	4.30	4.44	4.35	4.71	5.02	4.75	4.47
12	5.35	15.7	16.4	19.8	23.0	30.3	25.7	22.4	19.0	17.3	12.2
13	1.88	7.73	9.01	3.57	2.53	3.85	2.96	2.17	2.85	7.55	5.74
17	2.73	2.38	5.45	4.41	4.07	4.09	3.72	3.42	3.35	3.42	3.17
18	4.75	5.09	4.91	5.53	4.81	8.17	8.61	8.67	11.6	11,6	11.4
19	3.01	3.07	2.75	3.80	3.25	3.37	5.80	6.01	6.15	5.18	3.83
21	2.99	3.35	3.03	3.04	16.8	18.2	16.1	13.2	14.9	15.0	5.24
22	2.29	2.86	5.60	5.39	6.32	8.49	7.42	7.20	6.64	7.09	7.36
23	7.02	8.00	8.99	11.0	12.5	12.1	12.8	11.8	10.5	12.1	10.1
24	6.62	8.84	7.30	6.38	6.45	6.59	6.82	10.6	14.5	13.2	12.8
26	4.88	4.61	4.52	4.46	4.52	4.26	5.18	5.40	5.94	5.72	5.82
27	12.6	12.4	12.2	12.5	12.5	13.1	16.3	18.0	18.9	19.6	17.3
28	3.94	5.58	5.39	5.32	5.39	5,11	5.73	5.65	5.30	5.49	5.55
29	17.6	36.7	18.3	17.3	16.6	15.9	15.9	14.3	16.2	12.8	13.2
30	7.88	7.46	8.67	9.54	9.09	11.0	12.9	22.9	31.3	31.8	33.1
31	5.97	5.82	5.20	6.72	15.6	13.4	17.3	18.5	23.9	16.3	5.70
32	2.94	2.24	2.03	2.22	5.50	17.3	9.42	9.07	8.63	7.64	3.50
33	5.52	6.26	12.8	9.09	12.0	14.1	21.6	16.6	16.5	15.8	14.1
34	1.52	1.72	1.69	1.62	1.73	2.66	2.91	2.87	3.17	2.10	1.90
35	3.44	7.42	14.6	18.9	16.0	12.5	10.1	9.56	7.60	8.18	7.21
36	4.61	5.01	5.51	6.11	13.0	11.6	10.3	10.4	10.9	10.3	9.93
Min	1.52	1.72	1.69	1.62	1.73	2.28	2.81	2.17	2.20	2.10	1.90
Max	17.6	36.7	21.4	22.3	23.0	30.3	33.1	29.8	32.4	31.8	33.1
Ave	5.45	7.83	8.30	8.50	10.5	11.9	12.2	12.0	12.5	12.0	10.6
90 <sup>th</sup> %ile	9.19	12.8	16.4	18.9	18.3	19.6	21.6	22.3	22.9	19.1	17.1

**Table S6a:** Summary of September/October sequential sampling results used in data analyses. Samples that were above the lead AL are in bold, and samples that contained visible particulates are shaded yellow.

		Sept/O	ct Sequenti	al Samplin	g Results by	y Site/Liter	(μg/L)		
					Liter				
Site	12	13	14	15	16	17	18	19	20
01	13.9	14.1	11.7						
03									
05	W 100								
06	00 WI								
07	12.7	9.29	6.52	6.03	ne ne			~~	
08	12.8	9.34	7.93	6.27					
09	Mil Mil			an an	and and		~~		
10		27.1	21.1	10.7					
11	ner ne	na un		ne no.	AM NA			AL NA	
12	6.98	3.28	2.04						
13	W4 100						~~		
17	2.84	2.62	2.59						
18									
19									
21	W1 84						w.w	•••	
22									
23	ner ne	na un		ner no.	PAR NA		as to	na na	~~
24	12.8	15.3	15.4						
26	No. of the last						~~		
27	16.0	12.8	9.24						
28	na na						~~	~~	
29	11.1	10.1	9.21	9.01	9.29	8.99	8.77	8.73	8.39
30									
31	4.17								
32	Part Sura	m m		na sa	An ma			~~	
33	12.4	11.5	10.1						
34	uu uu			14.44			w. w	w. w.	
35									
36	na na						~~	~~	
Min	2.84	2.62	2.04	6.03	9.29	8.99	8.77	8.73	8.39
Max	16.0	27.1	21.1	10.7	9.29	8.99	8.77	8.73	8.39
Ave	10.6	11.5	9.58	8.00	9.29	8.99	8.77	8.73	8.39
90 <sup>th</sup> %ile	13.9	15.3	15.4	10.7	9.29	8.99	8.77	8.73	8.39

**Table S6b:** Summary of Supplemental September/October sequential sampling results not used in data analyses. Samples that were above the lead AL are in bold, and samples that contained visible particulates are shaded yellow.

**Stagnation Times** – Volunteers were asked to record the date and time water was last used, and the date and time when sampling began for each set of samples. Table S6c is a summary table which contains the stagnation times for the sequential samples, which is the amount of time the water sat motionless in the household prior to sample collection.

	ample Collection	7			
	e Sequential Sampling		Oct Sequential Sampling		
Site	Stagnation Time (hrs:mins)	Site	Stagnation Time (hrs:mins)		
1	6:32	1	8:04		
3	7:13	3	7:45		
4	7:06	5	7:45		
5	7:00	6	8:00		
6	9:10	7	7:13		
7	7:24	8	6:05		
8	7:35	9	7:20		
9	8:15	10	***		
10	6:06	11	7:08		
11	7:00	12	6:26		
12	8:06	13	***		
17	6:25	17	6:55		
18	8:43	18	12:53		
19	6:30	19	***		
21	6:15	21	6:00		
22	6:20	22	6:15		
23	7:45	23	9:00		
24	8:33	24	7:01		
25	8:32	26	7:00		
26	7:00	27	7:45		
27	7:00	28	8:00		
29	***	29	***		
31	7:26	30	10:45		
32	7:13	31	7:30		
33	7:02	32	6:54		
35	7:04	33	9:06		
36	7:45	34	7:05		
38	7:13	35	6:55		
		36	8:47		

<sup>\*\*\*</sup>Volunteer did not record date/time the water was last used, but said it was the day before and was at least 6 hours before sampling.

Table S6c: Summary of stagnation times for sequential sampling.

**Seasonal Variability** – Table S6d contains a site by site comparison of lead concentrations.

Seasonal Variability (Spring vs. Fall & Summer vs. Fall)									
First-Draw NHU	Sept/Oct >	First-Draw PF	Sept/Oct >	Sequential	Sept/Oct >				
riist-Diaw Nnu	Mar/Apr	FIISI-Diaw PF	Mar/Apr	Samples	June				
No. of Sample	28	No. of Sample	29	No. of Sample	285				
Pairs	28	Pairs	29	Pairs	203				
No. Higher in	19	No. Higher in	20	No. Higher in	156				
Sept/Oct	19	Sept/Oct	20	Sept/Oct	130				
% Higher in	68%	% Higher in	69%	% Higher in	55%				
Sept/Oct	0070	Sept/Oct	0970	Sept/Oct	3370				
First-Draw Samples: Mar/Apr vs. Sept/Oct (Same Site, Same First-Draw Protocol Compared)									
Sequential Samples: June vs. Sept/Oct (Same Site/Same Liter Compared)									

Table S6d: Seasonal variability effects observed.

Flushed sample results – The results of the flushed samples collected in September and October are tabulated in Table S7 by site. Most sites collected a 3 minute and 5 minute flushed sample. Some sites collected a 3, 5, and 7 minute flushed sample; and one site (site 29) collected a 3, 5, and 10 minute flushed sample, due to the length of the service line (159 ft / 48.5 m).

A flushed sample is collected by fully opening the sample tap and letting the water run for at least five minutes prior to a minimum 6 hour stagnation period. The date and time of the PF was recorded. After the minimum 6 hour stagnation period, and immediately before beginning the flushed sample collection, the date and time were again recorded and used as the start of sampling. The 3, 5, 7 and 10 minutes are measured from that start time, and water was not turned off between samples. For sequential sampling and flushed samples, the water was not turned off between samples.

EPA's current Public Notification Handbook includes instructions that advise residents to run the water between 30 and 45 seconds before collecting water for consumption if the water has not been used for an extended period of time. Running the water (flushing) for 45 seconds resulted in high lead levels at the tap for some sites. The flushed sampling results in this study indicate that EPA should develop a more appropriate flushing guidance, based on whether a home has a LSL or not, and the length of the LSL.

For homes with long LSLs, such as Site 29 (159 ft / 48.5 m), flushing may not be a practical way to reduce lead levels, as lead levels did not decline any further following 3, 5 and 10 minutes of flushing. In the case of site 29, residents would likely have a minimum of approximately 8 to  $11 \mu g/L$  of lead in the drinking water for all water consumed, and should consider installing a water filter or using bottled water for drinking and cooking.

Flushed Sample Summary Table (μg/L)						
Site	Mar/Apr 2011 NHU 45sec	Mar/Apr 2011 PF 45sec	Sept/Oct 2011 3min	Sept/Oct 2011 5min	Sept/Oct 2011 7min	Sept/Oct 2011 10min
01	11.3	11.9	6.48	6.56	6.97	
03	12.0	6.71	3.78	2.93		
04	6.76	2.56				
05	13.2	14.1				
06	1.90	2.13				
07	15.3	24.9	5.49	5.46	5.32	
08	32.2	28.0	8.25	5.54	5.71	
09	15.9	17.7	14.3	7.23		
10	25.0	21.6	4.95	4.30	4.09	
11	4.13	5.30	1.75	1.69		
12	17.2	5.45	1.78	1.45	1.33	
13	3.50	2.94				
17	4.00	3.70	2.88	2.76	2.86	
18	9.57	12.4	4.15	3.71		
19	4.69	8.27				
20	2.80	2.54				
21	6.87	13.8				
22	9.19	7.93				
23	13.1	11.5	5.64	4.54		
24	6.10	4.98	6.38	12.4		
25	3.75	ND				
26	3.02	3.45	5.06	3.23		
27	4.53	3.76	15.0	14.1		
28	4.99	4.70	4.82	3.26		
29	13.5	28.6	11.9	10.9		10.8
30	12.5	6.52	5.80	4.82		
31	3.16	12.3	3.78	3.76		
32	2.29	7.82				
33	16.4	14.0	4.40	4.06		
34	1.51	3.30	1.83	1.75		
35	5.28	10.5	5.53	4.03		
36	11.1	8.76	7.19	5.29		
38	1.60	2.30				1

NHU 45sec Samples were collected following the collection of the First-Draw NHU samples by running the water for 45 seconds following the collection of the First-Draw NHU sample.

PF 45sec Samples were collected following the collection of the First-Draw PF samples by running the water for 45 seconds following the collection of the First-Draw PF sample.

3min, 5min, 7min, and 10min flushed samples were collected after pre-flushing the tap for at least 5 minutes prior to the minimum 6 hour stagnation time during which no water was used in the home. Following the stagnation period and prior to sample collection, residents flushed the tap for 3 min to collect the 3min sample, and then an additional 2min for the 5min sample or 4min for the 7min sample. One site (site 29) had the longest lead service line so this site collected a 3 min, 5 min and 10min flushed sample (water was flushed for an additional 5 minutes following the collection of the 5min sample to collect the 10 min flushed sample). Water was not turned off in between samples to avoid the water hammer effect. Residents were instructed to have the bottles ready to insert under the faucet at the appropriate time.

Site 20 and Site 21 are the same residence. Site 20 was the upstairs bathroom and Site 21 was the kitchen sink. Note that neither the 45sec NHU nor PF samples from the upstairs tap captured any LSL water, while at least one of the kitchen tap samples did.

**Table S7:** Summary table of flushed sample results. Samples that were above the lead AL are in bold, and samples that contained visible particulates are shaded yellow.

Classification of Disturbed LSL Sites – A summary of the classification of each site as "disturbed", "undisturbed", or "indeterminate" is presented in Table S8, along with the number of samples collected per site and the number and percentage of sample results above the lead action level. The results from the "disturbed" and "undisturbed" sites are consistent with other research efforts showing that LSL disturbances result in higher lead levels<sup>[1-3]</sup>.

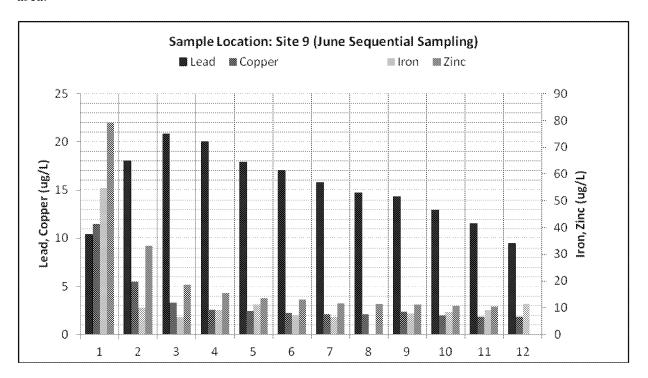
	Disturbed, Undisturbed and Indeterminate Site Summary							
Disturbed Sites	Total Samples Collected	# Samples Above AL (Disturbed)	Undisturbed Sites	Total Samples Collected	# Samples above AL (Undisturbed)	Indeterminate Sites	Total Samples Collected	# Samples above AL (Indeterminate)
01	27	16	03	27	4	12	27	17
05	27	2	04	14	0	21	27	7
07	27	11	06	27	0	33	27	6
08	27	19	11	27	0			
09	27	15	13	15	0			
10	27	15	18	27	0			
17	27	3	19	27	0			
27	27	5	22	27	0			
28	15	0	23	27	0			
29	27	15	24	27	0			
30	15	4	25	14	0			
31	27	10	26	27	0			
35	27	2	32	27	2			
			34	15	0			
			36	27	0			
			38	16	0			
Totals	327	117	Totals	371	6	Totals	81	30
% of sa	% of samples above AL: 36%			samples above	e AL: 2%	% of	samples abov	e AL: 37%

**Table S8:** Summary Table of Disturbed, Undisturbed and Indeterminate Sites, with the number and percentages of sample results above the lead AL for each site and each grouping.

Many direct LSL disturbances are localized to a specific segment of the LSL, and yet some sites have higher lead levels in sample liters over a significant portion of the LSL, not just in the immediate area of the LSL that was disturbed. A probable reason is that, except for the initial liter of water, each subsequent one-liter sample reflects both lead levels within the segment of the plumbing where the water stagnated as well as a contribution from the rest of the plumbing the water travelled through. For example, the fifth liter of water collected from a kitchen tap will not only capture the lead from the segment of LSL where the water stagnated, but it will also collect contributions from the plumbing downstream as the water passes through the remaining LSL and internal plumbing on the way to the kitchen tap. If the sample results only represented the portion of the plumbing where the water stagnated, it would be expected that a variety of metals would be found in the initial liters due to the presence of a variety of metallic plumbing materials and components, but only lead should be found in the LSL samples. In this study, a variety of metals was detected even in samples that represented LSL samples (Figure S6).

Specifically, for Site 9, information provided by the resident indicated that the internal pipe from the LSL to the kitchen tap was galvanized iron pipe. This was confirmed by the co-occurrence of higher levels of zinc and iron within the first liter of water in figure S6. There were no copper pipes in the home, so the presence of the copper is indicative of brass components (faucet, connectors, shut-off valve(s), and the water meter). Trace amounts of iron, zinc and copper are captured in the later liter samples as the water flows through the internal plumbing en route to the kitchen tap, along with traces of iron, potentially from the water main. It can reasonably be

assumed that the same phenomenon occurred for lead. Disturbed areas of the LSL have damaged scale, which can expose water passing through them to fresh lead. Therefore, lead measured in any sample upstream of the damaged area may include lead contributions from the damaged area.



**Figure S6:** The LSL at Site 9 measures approximately 102 ft (31.1 m) from the water main to the meter. From the meter, there is approximately 13.5 ft (4.1 m) of 1 inch (2.54 cm) galvanized pipe to the kitchen tap.

Variability of lead levels in City B – A second city, City B, exceeded the lead AL during the July-Dec 2010 monitoring period, and was required to comply with the LSL replacement requirements in the LCR. Table S9 contains the compliance monitoring history for City B.

Monitoring Period Begin Date	Monitoring Period End Date	Number of Samples	Lead 90 <sup>th</sup> Percentile Value (µg/l)
7/1/2011	12/31/2011	101	12
1/1/2011	6/30/2011	130	14
7/1/2010	12/31/2010	105	23
1/1/2009	12/31/2009	51	15
1/1/2008	12/31/2008	58	14
1/1/2007	12/31/2007	50	11
1/1/2006	12/31/2006	60	14
1/1/2005	12/31/2005	54	13
1/1/2004	6/30/2004	104	12
7/1/2003	12/31/2003	108	12
1/1/2002	12/31/2004	50	15
1/1/1999	12/31/1999	55	14
1/1/1998	12/31/1998	50	6
1/1/1997	12/31/1997	50	7
7/1/1996	12/31/1996	50	15
1/1/1996	6/30/1996	50	15
7/1/1992	12/31/1992	50	15
1/1/1992	6/30/1992	50	21

Table S9: City B 90<sup>th</sup> percentile compliance values (1992 – 2012). Samples that were above the lead AL are in bold.

The sampling instructions presented in Figure S7 are in accordance with the LCR, and were used to collect the LSL samples in City B, which has approximately 25,000 LSLs.

#### Instructions for Lead Sample Collection

- 1 Make sure the faucet used for sample collection is <u>NOT</u> attached to a water softener or any filtering device.
- 2 At bedtime, make sure the following rule is followed:
  - The water for the entire house, not just the faucet that is being used for collection, remains undisturbed for a period of at least six hours.
    - No faucets in the house are used, which includes the bath tub, shower and sinks.
    - The tollet is not flushed during this time period.
    - The water is not run for an ice maker.
- 3 When you are ready to collect the sample:
  - Make sure the sample is taken before any other water is used.
    - · Open the collection container.
    - \* Turn on the cold water.
    - \* Allow the water to run until there is a significant change in temperature.
    - Fill the container to the shoulder.
    - Do not rinse the bottle out.
    - Immediately cap the sample container.
- 4 Fill out the enclosed chain of custody form and survey.
- 5 Fold and secure the chain of custody form and survey with a rubber band around the outside of the sample container.
  - o Place the container outside where it was delivered.
- A city utilities employee will pick up the sample container. No one will enter your home. The sample must be left outside to be picked up.

Figure S7: LSL sampling instructions provided by City B to residents.

The sampling protocol used for collecting LSL samples ("allow the water to run until there is a significant change in temperature") can result in some sample results reflecting lead levels from internal plumbing rather than from within the LSLs.

The results from City B are presented below in Figure S8. Similar to the results presented for the study of Chicago, City B's results show significant variability in LSL lead levels across the system. Following the 2010 lead AL exceedance, the City B took 1,975 LSL samples, with a total of 1,762 results (89%) below the lead AL and 213 results (11%) above the lead AL. LSL results above the AL were significantly variable, ranging from  $16~\mu g/L$  to  $580~\mu g/L$  with a large number of sample results in exceedance of  $50~\mu g/L$ .

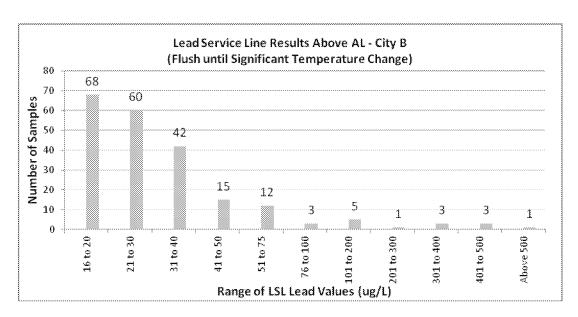


Figure S8: Range of lead values for City B LSL sampling results

Sequential Sampling Summary Graphs – The headers are color-coded based on whether the site has a disturbed LSL (red) or an undisturbed LSL (green). Sites for which this could not be determined (indeterminate sites) are color-coded orange. Water usage information is listed for each site. The samples which contained visible particulates are highlighted yellow, and the results that are above the lead AL are in bold text in the data tables. For sites that conducted sequential sampling in both June and Sept/Oct, the sequential sampling profiles were generally consistent during both sampling periods (see Figures S9 – S40).

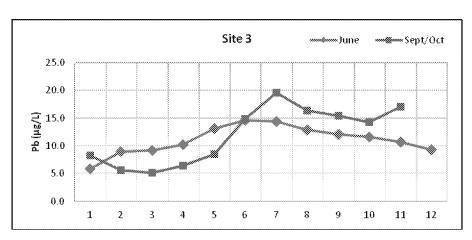
Liter	June	Sept/Oct
1	7.0	9.2
2	11	13
3	25	21
4	28	22
5	28	22
6	24	20
7	23	17
8	18	16
9	20	15
10	20	14
11	21	14
12	20	14
13		14
14		12



Disturbance(s): Water meter installed in 2010 Approximate LSL Length: 89 ft (27.1 m) Ave Monthly Water Use: 3,444 gal. (13,037 L)

Figure S9: Sequential Lead Results - Sample Site #1 (June and Sept/Oct)

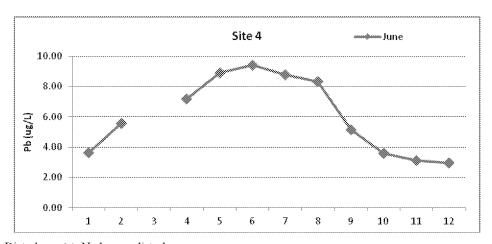
Site 3			
Liter	June	Sept/Oct	
1	5.8	8.3	
2	8.9	5.6	
3	9.2	5.2	
4	10	6.4	
5	13	8.5	
6	15	15	
7	14	20	
8	13	16	
9	12	15	
10	12	14	
11	11	17	
12	9.3		



Disturbance(s): No known disturbance Approximate LSL Length: 73 ft (22.3 m) Ave Monthly Water Use: Not metered

Figure S10: Sequential Lead Results - Sample Site #3 (June and Sept/Oct)

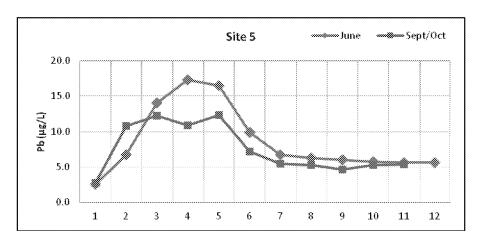
Site 4		
Liter	June	
1	3.61	
2	5.56	
3		
4	7.17	
5	8.90	
6	9.41	
7	8.78	
8	8.30	
9	5.14	
10	3.59	
11	3.11	
12	2.96	



Disturbance(s): No known disturbance Approximate LSL Length: Unknown Ave Monthly Water Use: Not metered

Figure S11: Sequential Lead Results - Sample Site #4 (June)

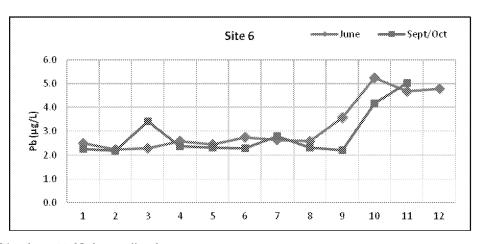
Liter	June	Sept/Oct
1	2.6	2.8
2	6.7	11
3	14	12
4	17	11
5	17	12
6	9.9	7.2
7	6.7	5.5
8	6.3	5.2
9	6.0	4.7
10	5.7	5.3
11	5.7	5.4
12	5.6	



Disturbance(s): Water meter installed in 2011 Approximate LSL Length: 80 ft (24.4 m) Ave Monthly Water Use: 10,400 gal. (39,368 L)

Figure S12: Sequential Lead Results - Sample Site #5 (June and Sept/Oct)

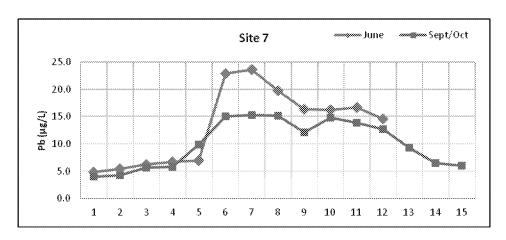
Site 6				
Liter	June	Sept/Oct		
1	2.5	2.3		
2	2.2	2.2		
3	2.3	3.4		
4	2.6	2.4		
5	2.4	2.3		
6	2.8	2.3		
7	2.7	2.8		
8	2.6	2.3		
9	3.6	2.2		
10	5.3	4.2		
11	4.7	5.0		
12	4.8			



Disturbance(s): No known disturbance Approximate LSL Length: 60 ft (18.3 m) Ave Monthly Water Use: Not metered

Figure S13: Sequential Lead Results - Sample Site #6 (June and Sept/Oct)

Liter	June	Sept/Oct
1	4.9	4.0
2	5.5	4.3
3	6.3	5.7
4	6.7	5.8
5	7.0	9.9
6	23	15
7	24	15
8	20	15
9	16	12
10	16	15
11	17	14
12	15	13
13		9.3
14		6.5
15		6.0



Disturbance(s): Street excavation, potential installation of Cu whip at service connection in 2008 Approximate LSL Length: 59+ ft (18.0+ m)

Ave Monthly Water Use: Not metered

Figure S14: Sequential Lead Results - Sample Site #7 (June and Sept/Oct)

Liter	June	Sept/Oct
1	11	9.2
2	13	9.0
3	22	10
4	20	12
5	32	18
6	34	25
7	32	23
8	29	22
9	32	23
10	30	19
11	24	16
12	19	13
13		9.3
14		7.9
15		6.3

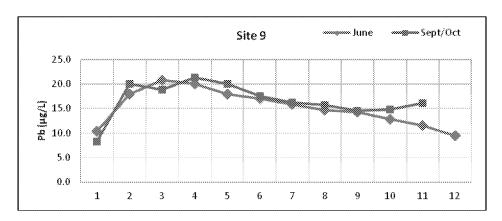


Disturbance(s): Leak in parkway, repaired roundway in 2005.

Approximate LSL Length: 57 ft (17.4 m) Ave Monthly Water Use: Not metered

Figure S15: Sequential Lead Results - Sample Site #8 (June and Sept/Oct)

Liter	June	Sept/Oct
1	10	8.3
2	18	20
3	21	19
4	20	21
5	18	20
6	17	18
7	16	16
8	15	16
9	14	15
10	13	15
11	12	16
12	10	



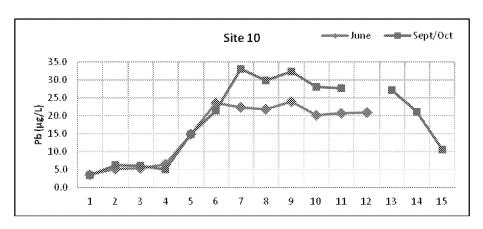
Disturbance(s): Water meter installed in 2008.

Approximate LSL Length: 102 ft (31.1 m)

Ave Monthly Water Use:  $3,190 (12,075 \, L)$  – In Sept 2011, usage was  $24,000 \, gal. (90,850 \, L)$  due to hose left running for one or more days. In calculating the overall average, the Sept 2010 value of  $8,000 \, gal. (30,283 \, L)$  was also used for Sept 2011 instead of the  $24,000 \, gal. (90,850 \, L)$  value.

Figure S16: Sequential Lead Results - Sample Site #9 (June and Sept/Oct)

Liter	June	Sept/Oct
1	3.7	3.5
2	5.2	6.3
3	5.4	6.2
4	6.5	5.1
5	15	15
6	24	21
7	22	33
8	22	30
9	24	32
10	20	28
11	21	28
12	21	
13		27
14		21
15		11

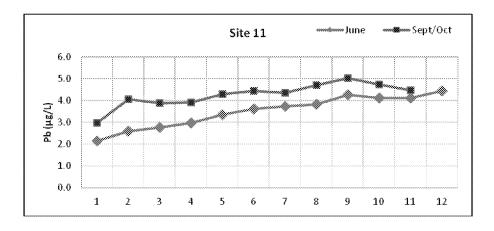


Disturbance(s): Service leak repair, water meter installed in 2009.

Approximate LSL Length: 48+ ft (14.6 m) Ave Monthly Water Use: 1,826 gal. (6,912 L)

Figure S17: Sequential Lead Results - Sample Site #10 (June and Sept/Oct)

	Site 11		
Liter	June	Sept/Oct	
1	2.2	3.0	
2	2.6	4.1	
3	2.8	3.9	
4	3.0	3.9	
5	3.4	4.3	
6	3.6	4.4	
7	3.7	4.4	
8	3.8	4.7	
9	4.3	5.0	
10	4.1	4.8	
11	4.1	4.5	
12	4.4		



Disturbance(s): No known disturbance Approximate LSL Length: 50 ft (15.2 m) Ave Monthly Water Use: Not metered

Figure S18: Sequential Lead Results - Sample Site #11 (June and Sept/Oct)

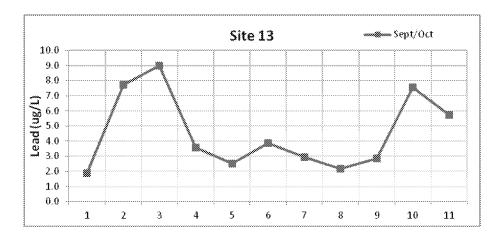
Site 12		
Liter	June	Sept/Oct
1	1.8	5.4
2	3.0	16
3	3.6	16
4	6.7	20
5	21	23
6	27	30
7	26	26
8	25	22
9	25	19
10	22	17
11	16	12
12	7.8	7.0
13		3.3
14		2.0



Disturbance(s): Indeterminate Approximate LSL Length: 53 (16.2 m) Ave Monthly Water Use: Not metered

Figure S19: Sequential Lead Results - Sample Site #12 (June and Sept/Oct)

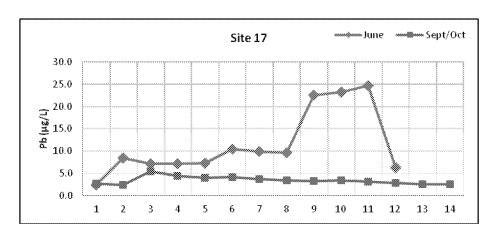
	Site 13		
Liter	Sept/Oct		
1	1.9		
2	7.7		
3	9.0		
4	3.6		
5	2.5		
6	3.9		
7	3.0		
8	2.2		
9	2.9		
10	7.6		
11	5.7		



Disturbance(s): No known disturbance Approximate LSL Length: 49+ ft (4.9 m) Ave Monthly Water Use: Not metered

Figure S20: Sequential Lead Results - Sample Site #13 (Sept/Oct)

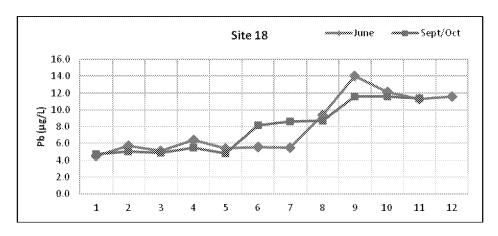
Liter	June	Sept/Oct
1	2.4	2.7
2	8.5	2.4
3	7.1	5.5
4	7.2	4.4
5	7.3	4.1
6	11	4.1
7	9.9	3.7
8	9.6	3.4
9	23	3.4
10	23	3.4
11	25	3.2
12	6.3	2.8
13		2.6
14		2.6



Disturbance(s): Meter replacement in 2008. Approximate LSL Length: 58+ ft (17.7+ m) Ave Monthly Water Use: 9,772 gal. (36,991 m)

Figure S21: Sequential Lead Results - Sample Site #17 (June and Sept/Oct)

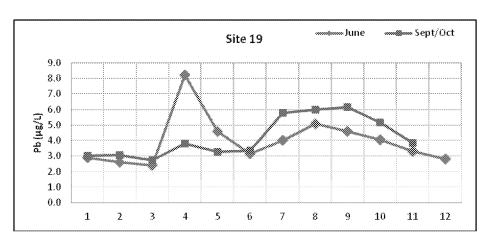
Site 18		
Liter	June	Sept/Oct
1	4.6	4.8
2	5.7	5.1
3	5.1	4.9
4	6.4	5.5
5	5.4	4.8
6	5.6	8.2
7	5.5	8.6
8	9.4	8.7
9	14	12
10	12	12
11	11	11
12	12	



Disturbance(s): No known disturbance Approximate LSL Length: 76 ft (23.2 m) Ave Monthly Water Use: Not metered

Figure S22: Sequential Lead Results - Sample Site #18 (June and Sept/Oct)

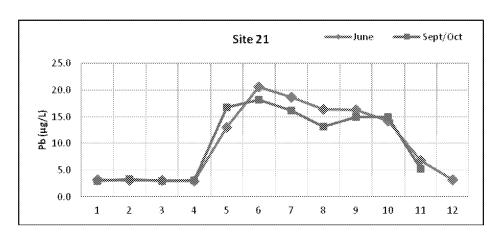
Site 19		
Liter	June	Sept/Oct
1	2.9	3.0
2	2.6	3.1
3	2.4	2.8
4	8.2	3.8
5	4.6	3.3
6	3.2	3.4
7	4.0	5.8
8	5.1	6.0
9	4.6	6.2
10	4.1	5.2
11	3.3	3.8
12	2.8	



Disturbance(s): No known disturbance Approximate LSL Length: 63 ft (19.2 m) Ave Monthly Water Use: Not metered

Figure S23: Sequential Lead Results - Sample Site #19 (June and Sept/Oct)

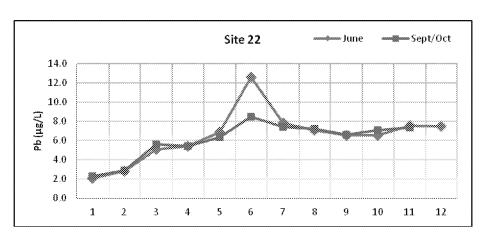
Site 21		
Liter	June	Sept/Oct
1	3.2	3.0
2	3.1	3.4
3	3.1	3.0
4	3.0	3.0
5	13	17
6	21	18
7	19	16
8	16	13
9	16	15
10	14	15
11	7.0	5.2
12	3.2	



Disturbance(s): Indeterminate Approximate LSL Length: 46 ft (14.0 m) Ave Monthly Water Use: Not metered

Figure S24: Sequential Lead Results - Sample Site #21 (June and Sept/Oct)

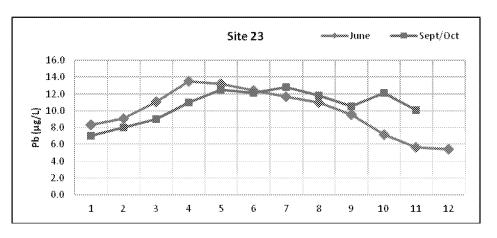
	Site 22		
Liter	June	Sept/Oct	
1	2.1	2.3	
2	2.8	2.9	
3	5.1	5.6	
4	5.4	5.4	
5	6.9	6.3	
6	13	8.5	
7	7.8	7.4	
8	7.1	7.2	
9	6.5	6.6	
10	6.6	7.1	
11	7.6	7.4	
12	7.5		



Disturbance(s): No known disturbance Approximate LSL Length: 65 ft (19.8 m) Ave Monthly Water Use: Not metered

Figure S25: Sequential Lead Results - Sample Site #22 (June and Sept/Oct)

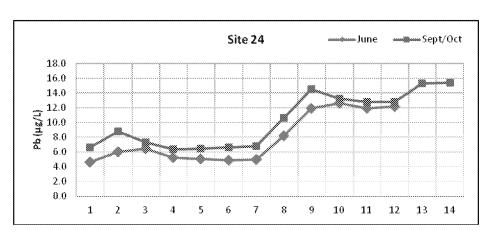
	Site 23		
Liter	June	Sept/Oct	
1	8.3	7.0	
2	9.1	8.0	
3	11	9.0	
4	14	11	
5	13	13	
6	12	12	
7	12	13	
8	11	12	
9	9.6	11	
10	7.2	12	
11	5.7	10	
12	5.4		



Disturbance(s): No known disturbance Approximate LSL Length: 66 ft (20.1 m) Ave Monthly Water Use: Not metered

Figure S26: Sequential Lead Results - Sample Site #23 (June and Sept/Oct)

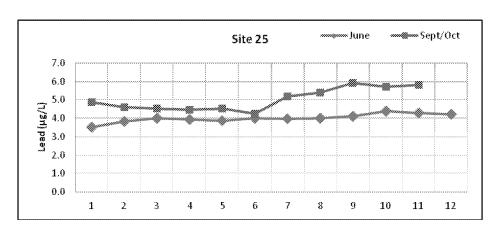
	Site 24		
Liter	June	Sept/Oct	
1	4.6	6.6	
2	6.1	8.8	
3	6.4	7.3	
4	5.2	6.4	
5	5.1	6.5	
6	4.9	6.6	
7	5.0	6.8	
8	8.2	11	
9	12	15	
10	13	13	
11	12	13	
12	12	13	
13		15	
14		15	



Disturbance(s): No known disturbance Approximate LSL Length: 56 ft (17.1 m) Ave Monthly Water Use: Not metered

Figure S27: Sequential Lead Results - Sample Site #24 (June and Sept/Oct)

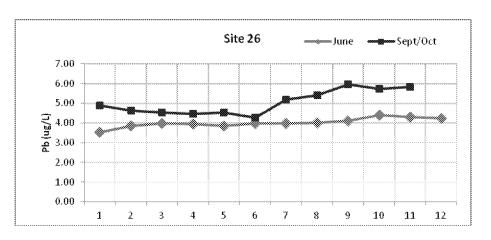
	Site 25		
Liter	June	Sept/Oct	
1	3.5	4.9	
2	3.8	4.6	
3	4.0	4.5	
4	3.9	4.5	
5	3.9	4.5	
6	4.0	4.3	
7	4.0	5.2	
8	4.0	5.4	
9	4.1	5.9	
10	4.4	5.7	
11	4.3	5.8	
12	4.2		



Disturbance(s): No known disturbance Approximate LSL Length: 70 ft (21.3 m) Ave Monthly Water Use: Not metered

Figure S28: Sequential Lead Results - Sample Site #25 (June and Sept/Oct)

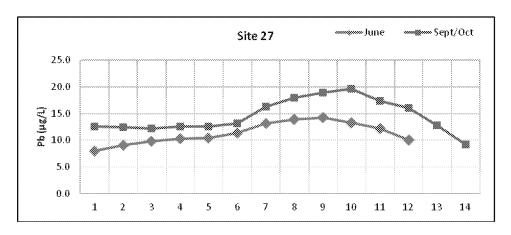
	Site 26		
Liter	June	Sept/Oct	
1	3.5	4.9	
2	3.8	4.6	
3	4.0	4.5	
4	3.9	4.5	
5	3.9	4.5	
6	4.0	4.3	
7	4.0	5.2	
8	4.0	5.4	
9	4.1	5.9	
10	4.4	5.7	
11	4.3	5.8	
12	4.2		



Disturbance(s): No known disturbance Approximate LSL Length: 66 ft (20.1 m) Ave Monthly Water Use: Not metered

Figure S29: Sequential Lead Results - Sample Site #26 (June and Sept/Oct)

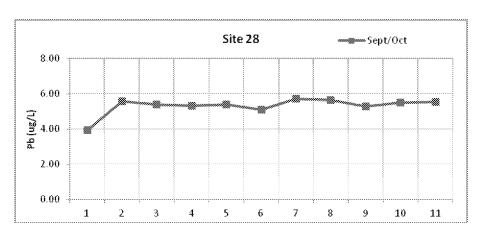
Liter	June	Sept/Oct
1	8.1	13
2	9.1	12
3	9.8	12
4	10	13
5	10	13
6	11	13
7	13	16
8	14	18
9	14	19
10	13	20
11	12	17
12	10	16
13		13
14		9.2



Disturbance(s): Meter replacement in 2010. Approximate LSL Length: 47+ ft (14.3 m) Ave Monthly Water Use: 4267 gal. (16,152 L)

Figure S30: Sequential Lead Results - Sample Site #27 (June and Sept/Oct)

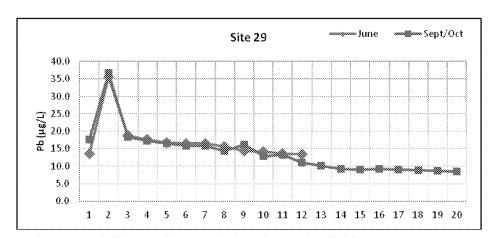
k	
Liter	Sept/Oct
1	3.9
2	5.6
3	5.4
4	5.3
5	5.4
6	5.1
7	5.7
8	5.7
9	5.3
10	5.5
11	5.6



Disturbance(s): Meter replacement in 2009. Approximate LSL Length: 61+ ft (18.6+ m) Ave Monthly Water Use: 4273 gal. (16,175 L)

Figure S31: Sequential Lead Results - Sample Site #28 (Sept/Oct)

Liter	June	Sept/Oct
1	14	18
2	36	37
3	19	18
4	18	17
5	17	17
6	17	16
7	17	16
8	16	14
9	14	16
10	14	13
11	14	13
12	13	11
13		10
14		9.2
15		9.0
16		9.3
17		9.0
18		8.8
19		8.7
20		8.4

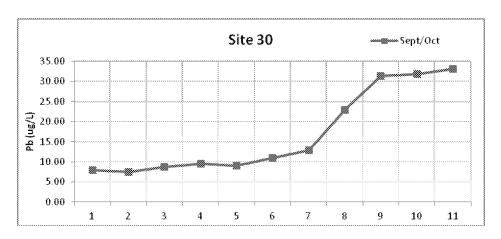


Disturbance(s): Probable Approximate LSL leak repair, meter installed in 2010. Approximate LSL Length: 159 ft (48.5 m)

Approximate LSL Length: 159 ft (48.5 m) Ave Monthly Water Use: 1,438 gal. (5,443 L)

Figure S32: Sequential Lead Results - Sample Site #29 (June and Sept/Oct)

Liter	Sept/Oct
1	7.9
2	7.5
3	8.7
4	9.5
5	9.1
6	11
7	13
8	23
9	31
10	32
11	33

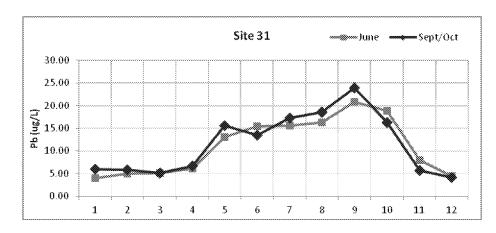


Disturbance(s): Broken water main in 2000, sidewalk replaced & street re-surfacing.

Approximate LSL Length: 49+ ft (14.9 m) Ave Monthly Water Use: Not metered

Figure \$33: Sequential Lead Results - Sample Site #30 (Sept/Oct)

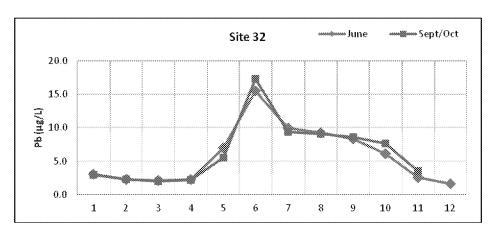
Liter	June	Sept/Oct
1	4.0	6.0
2	5.0	5.8
3	5.1	5.2
4	6.2	6.7
5	13	16
6	15	13
7	16	17
8	16	19
9	21	24
10	19	16
11	8	5.7
12	4.5	4.2



Disturbance(s): Approximate LSL leak repair in 2010. Approximate LSL Length: 71+ ft (21.6+ m) Ave Monthly Water Use: Not metered

Figure S34: Sequential Lead Results - Sample Site #31 (June and Sept/Oct)

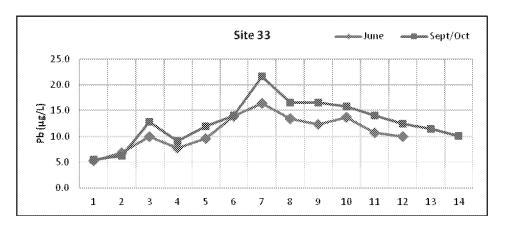
Site 32		
Liter	June	Sept/Oct
1	3.1	2.9
2	2.3	2.2
3	2.1	2.0
4	2.3	2.2
5	7.0	5.5
6	16	17
7	9.9	9.4
8	9.3	9.1
9	8.3	8.6
10	6.1	7.6
11	2.6	3.5
12	1.7	



Disturbance(s): No known disturbance Approximate LSL Length: 43 ft (13.1 m) Ave Monthly Water Use: Not metered

Figure S35: Sequential Lead Results - Sample Site #32 (June and Sept/Oct)

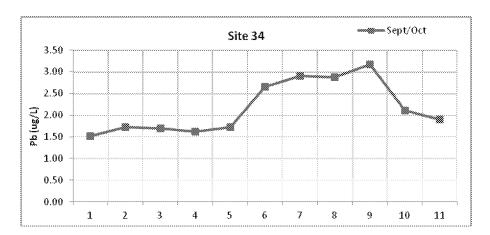
Site 33		
Liter	June	Sept/Oct
1	5.2	5.5
2	6.9	6.3
3	10	13
4	7.7	9.1
5	9.6	12
6	14	14
7	16	22
8	14	17
9	12	17
10	14	16
11	11	14
12	10	12
11		12
12		10



Disturbance(s): Indeterminate Approximate LSL Length: 43+ ft (13.1 m) Ave Monthly Water Use: Not metered

Figure S36: Sequential Lead Results - Sample Site #33 (June and Sept/Oct)

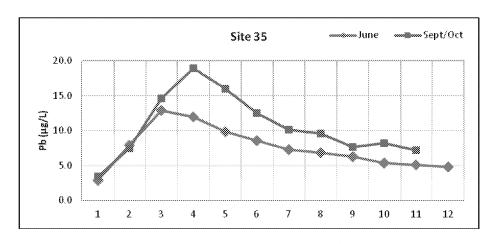
Site 34	
Liter	Sept/Oct
1	1.5
2	1.7
3	1.7
4	1.6
5	1.7
6	2.7
7	2.9
8	2.9
9	3.2
10	2.1
11	1.9



Disturbance(s): No known disturbance Approximate LSL Length: Unknown Ave Monthly Water Use: Not metered

Figure S37: Sequential Lead Results - Sample Site #34 (Sept/Oct)

Liter	June	Sept/Oct
1	2.9	3.4
2	7.9	7.4
3	13	15
4	12	19
5	9.9	16
6	8.6	13
7	7.3	10
8	6.8	9.6
9	6.2	7.6
10	5.3	8.2
11	5.0	7.2
12	4.8	

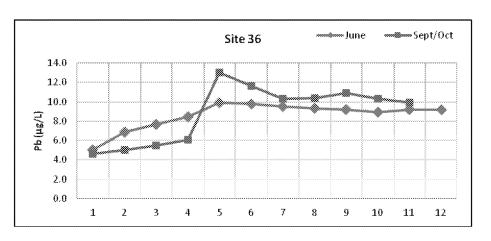


Disturbance(s): Meter installed in Aug 2011 (between June and Sept/Oct sampling). Approximate LSL Length: 80 ft (24.4 m)

Ave Monthly Water Use: 4,667 gal. (17,667 L) – Data available only for Aug-Oct 2011

Figure S38: Sequential Lead Results - Sample Site #35 (June and Sept/Oct)

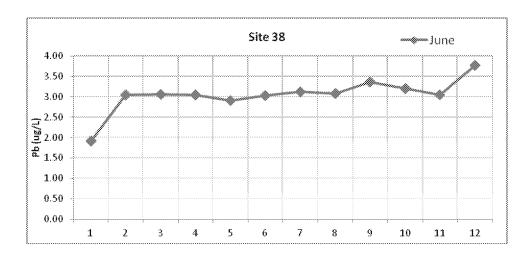
Site 36		
Liter	June	Sept/Oct
1	5.0	4.6
2	6.9	5.0
3	7.7	5.5
4	8.5	6.1
5	9.9	13
6	9.8	12
7	9.5	10
8	9.3	10
9	9.2	11
10	8.9	10
11	9.2	9.9
12	9.2	



Disturbance(s): No known disturbance Approximate LSL Length: 83+ ft (25.3 m) Ave Monthly Water Use: Not metered

Figure S39: Sequential Lead Results - Sample Site #36 (June and Sept/Oct)

Site	: 38
Liter	June
1	1.9
3	3.0
	3.1
4	3.0
5	2.9
6	3.0
7	3.1
8	3.1
9	3.4
10	3.2
11	3.0
12	3.8



Disturbance(s): No known disturbance Approximate LSL Length: 51 ft (15.5 m) Ave Monthly Water Use: Not metered

Figure S40: Sequential Lead Results - Sample Site #38 (June)

#### Sampling collection and reporting instructions and forms

*March/April sampling* – The sampling instructions and forms below were used in the March/April sampling. Sampling was scheduled to conclude in March, but the sampling ran into April. As a result of the instructions below, some volunteers sampled one day at the kitchen tap and one day at the bathroom tap. The intent was to have all samples collected from the same tap, so volunteers that split the samples were asked to collect replacement samples so that a complete set of four samples was collected at the same tap. We chose the kitchen tap, and all samples collected thereafter were also collected at the kitchen tap. In addition, the 45-second flushed

sampling protocol was not used after the March/April sampling due to the complication with corroded galvanized pipe.

#### **General Sampling Instructions**

You will be taking a total of 8 samples for this study. One set of 4 samples will be taken in March 2011 and one set of 4 samples (using the same instructions) will be taken in August 2011.

#### General Instructions for all four samples of a set

Sample #1 and Sample #2 must be collected one after another on the same day.

Sample #3 and Sample #4 must also be collected one after another on the same day, and within the same week as Sample #1 and Sample #2.

All samples should be collected from taps that are generally used by your household for drinking water. <u>Do not collect samples from a taps that have not been used within the last 24 hours</u>. Use a kitchen or bathroom cold-water faucet for your sampling.

<u>Do not collect samples from a tap that has a water filter or is connected to a water softener</u>. If you have a water softener or water filter on your kitchen tap, collect your sample from a bathroom tap that is not attached to the water softener or water filter, if possible.

#### Instructions for Collecting Sample #1

Important: Please make sure you use the bottle labeled 'Sample #1' for your first sample!

<u>Collecting Sample #1</u>: The first sample is to be collected after water throughout the household *has not been used* for a minimum of 6 hours (example: midnight to 6am). During these 6 hours, do not flush toilets, shower, or run water from other faucets. The best time to collect samples is either:

- 1) First thing in the morning, before any water is used in the household; or 2) Immediately upon returning from work, and prior to using any water, as long as water has not been used in the household during the day.
- 1. When you are ready to collect your first sample, use the sample bottle labeled 'Sample #1'.
- 2. Do not run any water from the tap before collecting the first sample.
- 3. Place the opened sample bottle below the faucet and gently open the cold water tap.
- 4. Fill the sample bottle as you would normally fill a glass of water for drinking, up to the neck of the bottle (see photographs below) and turn off the water. Tightly cap the sample bottle.



Fill the bottle up to here Do not overfill





#### **Instructions for Collecting Sample #2**

Important: Please make sure you use the bottle labeled 'Sample #2' for your second sample!

<u>Collecting Sample #2</u>: This sample is to be collected from the same faucet as Sample #1, immediately after collecting Sample #1.

1. Immediately after collecting Sample #1, run the water for 45 seconds. Shut off the water, and place the opened

- sample bottle (labeled Sample #2) below the faucet and gently open the cold water tap.
- 2. Fill the sample bottle as you would normally fill a glass of water for drinking, up to the neck of the bottle (see photographs on first page) and turn off the water. Tightly cap the sample bottle.

#### Instructions for Collecting Sample #3

#### Important: Please make sure you use the bottle labeled 'Sample #3' for your third sample!

Collecting Sample #3: Collect on a different day in the same week as Samples #1 & #2.

- 1. Before letting the water sit for a minimum of 6 hours, run the water from the faucet for 5 minutes at a high rate, and then do not use any water in the household for at least 6 hours after that (Example: Run the water for 5 minutes at midnight before going to bed, and then do not use any water in the household until collecting the third sample at 6 am the following morning).
- 2. Do not run any more water from the tap before collecting the third sample. Place the opened sample bottle below the faucet and gently open the cold water tap.
- 3. Fill the sample bottle as you would normally fill a glass of water for drinking, up to the neck of the bottle (see photographs on first page) and turn off the water. Tightly cap the sample bottle.

#### Instructions for Collecting Sample #4

#### Important: Please make sure you use the bottle labeled 'Sample #4' for your fourth sample!

<u>Collecting Sample #4</u>: This sample is to be collected from the same faucet as Sample #3.

- 1. Immediately after collecting Sample #3, <u>run the water for 45 seconds</u>. Shut off the water, and place the opened sample bottle (labeled Sample #4) below the faucet and gently open the cold water tap.
- 2. Fill the sample bottle as you would normally fill a glass of water for drinking, up to the neck of the bottle (see photographs on first page) and turn off the water. Tightly cap the sample bottle.

**Figure S41:** March/April sampling instructions.

Sample Colle	ction and Reporting Page
Sample Reporting – Sample #1	EPA Use: Visible Particulate? Yes No
Sample ID (from Sample Bottle #1):	Date/time Sample #1 was collected:
Volunteer ID: Sampling I	ocation: Kitchen Faucet 🗌 Bathroom Faucet 🗍
Date/time the water was last used in household before coll	ecting Sample #1:
Was sample #1 collected from a faucet that has a water so	ftener or water filter? Yes No
Sample Reporting – Sample #2	EPA Use: Visible Particulate? Yes No
Sample ID (from Sample Bottle #2):	Date/time Sample #2 was collected:
Volunteer ID: Sampling I	ocation: Kitchen Faucet 🔲 Bathroom Faucet 🔲
Date/time the water was last used in household before coll	ecting Sample #2:
Was Sample #2 collected from the same faucet as Sample	#1: Yes \( \sum \) No \( \sup \)
Sample Reporting – Sample #3	EPA Use: Visible Particulate? Yes No
Sample ID (from Sample Bottle #3):	Date/time Sample #3 was collected:
Volunteer ID: Sampling I	ocation: Kitchen Faucet 🗌 Bathroom Faucet 🗍
Date/time the faucet was flushed before collecting Sample	#3:
Was sample #3 collected from a faucet that has a water so	ftener or water filter? Yes 🔲 No 🔲
Sample Reporting – Sample #4	EPA Use: Visible Particulate? Yes No No
Sample ID (from Sample Bottle #4):	Date/time Sample #4 was collected:
Volunteer ID: Sampling I	ocation: Kitchen Faucet 🔲 Bathroom Faucet 🔲
Date/time the faucet was flushed before collecting Sample	#4:
Was Sample #4 collected from the same faucet as Sample	#3: Yes \( \bigcap \) No \( \bigcap \)
Have there been any plumbing repairs or plumbing work new faucets)? Yes $\square$ No $\square$	done within the household during the last six months (including installation of
If yes, explain briefly (Example – 'New faucet installed one	week ago'):
FOR EPA USE: Samples received by	Date/Time:
Samples transferred to Region 5 Laboratory by	Date/Time:
Volunteer Certification: I have read the sampling instructions provided.	structions and have collected the samples in accordance with the
	OR
Signature/Date	OR Volunteer ID/Date

Figure S42: March/April sample collection and reporting form.

*Sequential Sampling Instructions for June* – The sampling instructions and forms below were used in the June sequential sampling.

Sequential Sampling Instructions		
Please read all instructions before beginning your sampling		
General Information •Use only the kitchen faucet for all of these samples.		
•Use only <b>cold water</b> and open the cold water tap all the way when filling the bottles.		
•Fill each bottle to the top of the label on the sample bottle.		
Sampling Instructions •The night before sampling (right before everyone goes to bed) run the water from the kitchen tap for at least 5 minutes. Write down the date/time you finished running the water on the form on the back side of this page.		
•The water must sit motionless in the home plumbing for at least 6 hours before collecting the samples so do not use water in the home after you finished running the water and until all samples are collected the following morning. Showering, flushing toilets, or other water use will affect the sampling results. It may help to tape a sign in the kitchen and bathrooms with a reminder not to use the water, in case people forget.		
• The bottles are numbered, and it is very important to collect them in order (Sample 1 first, Sample 2 second, etc.).		
•In the morning, when you are ready to sample, place the open bottles in order by sample number. You will be collecting the samples without shutting off the water in between samples, so you should remove the caps from all bottles so that you have all of the bottles ready to fill. You can put the caps on after all samples have been collected. Try not to let any water spill in between samples.		
•Write down the date/time right before you sample on the form on the back side of this page.		
•Begin by placing the Sample 1 bottle under the faucet and open the <b>cold water</b> slowly until the faucet is <u>fully open</u> . While one bottle is filling, grab the next bottle so that you are ready to move it under the faucet quickly.		
•Once the bottle is filled to the top of the label, quickly place the Sample 2 bottle under the faucet, and continue until you have filled all sample bottles.		
Sequential Sampling – Sample Collection and Reporting Form		
Volunteer ID:		
Sampling Information		
Date/time the water was last used in household (the night before collecting the samples):  Date/Time Volunteer Began Collecting Samples:		
Were All Samples Collected from the Kitchen Tap? Yes No		
FOR EPA USE: Samples received by Date/Time:		
Samples transferred to Region 5 Laboratory by Date/Time:		
EPA Use: Visible Particulate in any samples? Yes No I If Yes – List Samples With Particulate		
Volunteer Certification: I have read the sampling instructions and have collected the samples in accordance with the instructions provided.		
OR		
Signature/Date Volunteer ID/Date		

Figure S43: June sampling instructions and sample collection and reporting form.

**Sampling instructions for September/October** – In the final round of sampling, the number and type of samples was customized to each site and sites collected 3 days of sampling. The instructions below were for a site collecting one NHU First-draw sample, 11 sequential samples and a 2 flushed samples. Some sites collected additional sequential samples and some collected 3 flushed samples instead of two.

#### **Sampling Instructions**

#### Please read all instructions before you start sampling.

#### **General Information**

- ✓ Use **only the kitchen faucet** for all of these samples.
- ✓ Use only cold water.
- ✓ Open the cold water tap all the way when filling the bottles.
- ✓ Fill each bottle to the top of the label on the sample bottle.

#### Sampling Instructions

- ✓ There are three different sets of samples for you to collect (Sample Set #1, #2 and #3).
- ✓ Each set will be taken on a different day. (The three sampling sets do not have to be taken on three days in a row.)
- ✓ A section of the reporting form (attached) needs to be filled in for each day of sampling.

#### A) Sample Set #1 (1 bottle, Blue Label)

- 1. The water must sit motionless in the home plumbing for at least 6 hours before collecting the sample. Typically, the night before taking the sample, make sure that no one uses water in the home until you collect the sample from the kitchen the following morning.
- 2. In the morning, when you are ready to sample, write down the date/time on the attached form.
- 3. Fill up the bottle with the BLUE LABEL. That's it for collecting the first sample set.

#### B) Sample Set #2 "Sequential Sampling" (11 bottles, WHITE LABELS)

- 1. The night before sampling (right before everyone goes to bed) run the water from the kitchen tap for at least 5 minutes. Write down the date/time you finished running the water on the form. After running the water for 5 minutes, it should sit motionless in the home plumbing for at least 6 hours.
- 2. In the morning, your first water usage should be collecting eleven samples in a row (one after another). Use the bottles with the WHITE LABELS. The samples should be collected without shutting off the water in between samples. To do this, remove the caps from all eleven bottles before you turn on the water.
- 3. Place the eleven open bottles in order by sample number before you start collecting the samples Try not to waste water in between the samples. You can put the caps on after all 11 samples have been collected. The bottles are numbered Seq 01, to Seq 11. It is very important to collect the samples in order (Seq 01 first, Seq 02 second, etc.).
- 4. Use the attached reporting form to note the date and time that you started taking the sample set.

#### C) Sample Set #3 (2 Bottles, GREEN LABEL and YELLOW LABEL)

- 1. The night before sampling (right before everyone goes to bed) run the water from the kitchen tap for at least 5 minutes. Write down the date/time you finished running the water on the form. After running the water for 5 minutes, it should sit motionless in the home plumbing for at least 6 hours.
- 2. In the morning, when you are ready to sample, write down the date/time on the attached reporting form.
- 3. Run the water for 3 minutes, then collect a sample in the jar with the GREEN LABEL. Continue to let the water run for an additional 2 minutes (for a total of 5 minutes), and collect the final sample in the bottle with the YELLOW LABEL.

Figure S44: Sept/Oct sampling instructions.

Sample Collection and Report	ing – Sampling set # 1 (Blue label)
Volunteer ID:	•
Sampling Information	
Date/time the water was last used in household (the night before c	ollecting the samples):
Date/Time Volunteer Began Collecting Samples:	
Were All Samples Collected from the Kitchen Tap? Yes ☐ No ☐	
FOR EPA USE: Samples received by	Date/Time:
Samples transferred to Region 5 Laboratory by	Date/Time:
EPA Use: Visible Particulate in any samples? Yes No	If Yes – List Samples With Particulate
Sample Collection and Reporting - Sa	impling set # 2 (11 samples, White labels)
Volunteer ID:	
Sampling Information	
Date/time the water was last used in household (the night before c	ollecting the samples):
Date/Time Volunteer Began Collecting Samples:	
Were All Samples Collected from the Kitchen Tap? Yes $\  \  \  \  \  \  \  \  \  \  \  \  \ $	
FOR EPA USE: Samples received by	Date/Time:
Samples transferred to Region 5 Laboratory by	Date/Time:
EPA Use: Visible Particulate in any samples? Yes No	If Voc. List Complex With Danticulate
Sample Collection and Reporting - Sa	impling set #3 (Green and Yellow labels)
Volunteer ID:	•
Sampling Information	
Date/time the water was last used in household (the night before c	ollecting the samples):
Date/Time Volunteer Began Collecting Samples:	
Were All Samples Collected from the Kitchen Tap? Yes ☐ No ☐	<b>_</b>
FOR EPA USE: Samples received by	Date/Time:
Samples transferred to Region 5 Laboratory by	Date/Time:
EPA Use: Visible Particulate in any samples? Yes \( \scale= \) No \( \scale= \)	☐ If Yes – List Samples With Particulate
Volunteer Certification: I have read the sampling inst the instructions provided.	ructions and have collected the samples in accordance with
	OR
Signature/Date	Volunteer ID/Date

Figure S45: Sept/Oct sample collection and reporting form.

#### **Literature Cited/References**

- 1. Triantafyllidou, S.; Edwards, M., Galvanic corrosion after simulated small-scale partial lead service line replacements. *Journal American Water Works Association* **2011**, *103*, (9), 85-+.
- 2. Renner, R., Reaction to the Solution: Lead Exposure Following Partial Service Line Replacement. *Environmental health perspectives* **2010**, *118*, (5).
- 3. Cartier, C.; Arnold Jr, R. B.; Triantafyllidou, S.; Prévost, M.; Edwards, M., Effect of Flow Rate and Lead/Copper Pipe Sequence on Lead Release from Service Lines. *Water Research* **2012**, *46*, (13), 4142-4152.



make the comments available online at www.regulations.gov, including any personal information provided, unless a comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through www.regulations.gov or email. The www.regulations.gov Web site is an "anonymous access" system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an email comment directly to EPA without going through www.regulations.gov, your email address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD-ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at www.epa.gov/epahome/dockets.htm.

Docket: Documents in the docket are listed in the www.regulations.gov index. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute. Certain other materials, such as copyrighted material, are publicly available only in hard copy. Publicly available docket materials are available either electronically at www.regulations.gov or in hard copy at the OEI Docket in the EPA Headquarters Docket Center.

Dated: May 2, 2013.

#### Debra B. Walsh,

Acting Deputy Director, National Center for Environmental Assessment.

[FR Doc. 2013-18954 Filed 8-6-13; 8:45 am]

BILLING CODE 6560-50-P

#### **ENVIRONMENTAL PROTECTION AGENCY**

#### [FRL-9843-9]

#### Intent To Grant an Exclusive Patent License

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Notice of intent to grant an exclusive license.

**SUMMARY:** EPA hereby gives notice of its intent to grant an exclusive, royaltybearing, revocable license to practice the invention described and claimed in the U.S. patent entitled PROCESS FOR THE **BIODEGRADATION OF** HYDROCARBONS AND ETHERS IN SUBSURFACE SOIL BY INTRODUCTION OF A SOLID OXYGEN SOURCE BY HYDRAULIC FRACTURING, filed as U.S. serial number 10/395,893 on March 25, 2003 and issued as U.S. Patent 7,252,986 on August 7, 2007 to Foremost Environmental Solutions, L.L.C. of Denver, Colorado.

DATES: Comments on this notice must be received by EPA at the address listed below by August 22, 2013.

#### FOR FURTHER INFORMATION CONTACT:

Laura Scalise, Patent Attorney, Office of General Counsel (Mail Code 2377A), Environmental Protection Agency, Washington, DC 20460, telephone (202) 564-8303.

SUPPLEMENTARY INFORMATION: Pursuant to 35 U.S.C. 207 (Patents) and 37 CFR part 404 (U.S. Government patent licensing regulations), EPA hereby gives notice of its intent to grant an exclusive, royalty-bearing, revocable license to practice the invention described and claimed in the U.S. patent entitled PROCESS FOR THE BIODEGRADATION OF HYDROCARBONS AND ETHERS IN SUBSURFACE SOIL BY INTRODUCTION OF A SOLID OXYGEN SOURCE BY HYDRAULIC FRACTURING, filed as U.S. serial number 10/395,893 on March 25, 2003 and issued as U.S. Patent 7,252,986 on August 7, 2007 to Foremost Environmental Solutions, L.L.C. of

Denver, Colorado. The proposed exclusive license will contain appropriate terms, limitations, and conditions to be negotiated in accordance with 35 U.S.C. 209 and 37 CFR 404.5 and 404.7 of the U.S. Government patent licensing regulations.

EPA will negotiate the final terms and conditions and grant the exclusive license, unless within 15 days from the date of this notice EPA receives, at the

address below, written objections to the grant, together with supporting documentation. The documentation from objecting parties having an interest in practicing the above patent should include an application for an exclusive or nonexclusive license with the information set forth in 37 CFR 404.8. The EPA Patent Attorney and other EPA officials will review all written responses and then make recommendations on a final decision to the Director or Deputy Director of the National Risk Management Research Laboratory who have been delegated the authority to issue patent licenses under EPA Delegation 1-55.

Dated: July 31, 2013.

#### Kevin Miller,

Acting Associate General Counsel, General Law Office.

[FR Doc. 2013-19075 Filed 8-6-13; 8:45 am] BILLING CODE 6560-50-P

#### **ENVIRONMENTAL PROTECTION AGENCY**

[FRL-9843-4]

#### Meeting of the National Drinking Water **Advisory Council**

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Notice of a public meeting.

**SUMMARY:** The U.S. Environmental Protection Agency is announcing a meeting of the National Drinking Water Advisory Council (Council), established under the Safe Drinking Water Act (SDWA). This meeting is scheduled for October 9 and 10, 2013, in Arlington, VA. The Council typically considers various issues associated with drinking water protection and public water systems. During this meeting, the Council will focus discussions on the proposed regulatory revisions to the Lead and Copper Rule under the SDWA as well as other program issues.

DATES: The meeting on October 9, 2013 will be held from 8:30 a.m. to 5:00 p.m., Eastern Time, and on October 10, 2013 from 8:30 a.m. to 2:30 p.m., Eastern

ADDRESSES: The meeting will be held at the EPA Potomac Yard Conference Center at 2777 Crystal Drive, Arlington, Virginia, 22202, in room North 4830 (4th floor) and will be open to the public. All attendees must go through a metal detector, sign in with the security desk, and show government issued photo identification to enter government buildings.

FOR FURTHER INFORMATION CONTACT: Members of the public who would like to register and receive pertinent information, present an oral statement or submit a written statement for the October 9 and 10 meeting should contact Roy Simon, by September 6; by email at Simon.Roy@epa.gov; by phone at 202–564–3868; or by regular mail at U.S. Environmental Protection Agency, Office of Ground Water and Drinking Water (MC 4601M), 1200 Pennsylvania Avenue NW., Washington, DC, 20460. Further details about participating in the meeting can be found in the SUPPLEMENTARY INFORMATION section.

SUPPLEMENTARY INFORMATION:

Details about Participating in the Meeting: If you wish to attend the meeting, you should provide your email address when you register. The EPA will provide updated information on the October meeting to registered individuals and organizations in September 2013. The Council will allocate one hour for the public's input (1:00 p.m.-2:00 p.m., Eastern Time) at the meeting on Thursday, October 10, 2013. Oral statements will be limited to five minutes at the meeting. It is preferred that only one person present the statement on behalf of a group or organization. To ensure adequate time for public involvement, individuals or organizations interested in presenting an oral statement should notify Roy Simon no later than September 13, 2013. Any person who wishes to file a written statement can do so before or after the Council meeting. Written statements intended for the meeting must be received by September 27, 2013, to be distributed to all members of the Council before any final discussion or vote is completed. Any statements received on or after the date specified will become part of the permanent file for the meeting and will be forwarded to the Council members for their information.

National Drinking Water Advisory Council: The Council was created by Congress on December 16, 1974, as part of the SDWA of 1974, Public Law 93–523, 42 U.S.C. 300j–5, and is operated in accordance with the provisions of the Federal Advisory Committee Act (FACA), 5 U.S.C. App.2. The Council was established under the SDWA to provide practical and independent advice, consultation and recommendations to the EPA Administrator on the activities, functions, policies, and regulations required by the SDWA.

Special Accommodations: For information on access or services for individuals with disabilities, please contact Roy Simon at 202–564–3868 or by email at Simon.Roy@epa.gov. To

request accommodation of a disability, please contact Roy Simon at least 10 days prior to the meeting to give EPA as much time as possible to process your request.

Dated: July 30, 2013.

#### Eric M. Bissonette,

Acting Director, Office of Ground Water and Drinking Water.

[FR Doc. 2013-19080 Filed 8-6-13; 8:45 am] BILLING CODE 6560-50-P

# ENVIRONMENTAL PROTECTION AGENCY

[EPA-HQ-OW-2010-0824; FRL-9678-5] RIN 2040-ZA18

#### Preliminary 2012 Effluent Guidelines Program Plan and 2011 Annual Effluent Guidelines Review Report

**AGENCY:** Environmental Protection Agency (EPA).

ACTION: Notice of availability.

SUMMARY: This notice announces the availability of the Preliminary 2012 Effluent Guidelines Program Plan ("Preliminary 2012 Plan") and EPA's 2011 Annual Effluent Guidelines Review Report, and solicits public comment on both. Clean Water Act (CWA) section 304(m), 33 U.S.C. 1314(m), requires EPA to biennially publish a plan for new and revised effluent guidelines, after public notice and comment, which identifies any new or existing industrial categories selected for effluent guidelines rulemaking and provides a schedule for such rulemaking. EPA works to publish a preliminary plan in the odd numbered years and a final plan in the even numbered years. The findings from the 2011 Annual Reviews were used in developing the Preliminary 2012 Plan and will be used in developing the Final 2012 Plan.

**DATES:** Submit comments on or before October 7, 2013.

ADDRESSES: Submit your comments on the 2011 Annual Reviews and Preliminary 2012 Plan identified by Docket ID No. EPA-HQ-OW-2010-0824, by one of the following methods:

- http://www.regulations.gov: Follow the on-line instructions for submitting comments.
- Email: ow-docket@epa.gov, Attention Docket ID No. EPA-HQ-OW-2010-0824.
  - Fax: (202) 566-9744
- *Mail*: Water Docket, Environmental Protection Agency, Mailcode: 2822T, Attention Docket ID No. EPA-HQ-OW-2010–0824, 1200 Pennsylvania Ave. NW., Washington, DC 20460.

• Hand Delivery: EPA Docket Center, EPA West, Room 3334, 1301 Constitution Avenue NW., Washington, DC, Attention Docket ID No. EPA-HQ-OW-2010-0824. Such deliveries are accepted only during the Docket Center's normal hours of operation, and special arrangements should be made for deliveries of boxed information.

Instructions: Direct your comments on the 2011 Annual Reviews and Preliminary 2012 Plan to Docket ID No. EPA-HQ-OW-2010-0824. EPA's policy is that all comments received will be included in the public docket without change and could be made available online at www.regulations.gov, including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through www.regulations.gov or email. The www.regulations.gov Web site is an "anonymous access" system, which means that EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an email comment directly to EPA without going through www.regulations.gov your email address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD-ROM you submit. If EPA cannot read your comment because of technical difficulties and cannot contact you for clarification, EPA might not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at http:// www.epa.gov/epahome/dockets.htm. For additional instructions on submitting comments, go to the SUPPLEMENTARY INFORMATION section of this document.

## **Submitting Confidential Business Information**

Do not submit confidential business information (CBI) to EPA through www.regulations.gov or email. Any CBI you wish to submit should be sent via a trackable physical method, such as Federal Express or United Parcel Service, to Mr. M. Ahmar Siddiqui, Document Control Officer, Engineering

# Detection and Evaluation of Elevated Lead Release from Service Lines: A Field Study

ISAWWA February 3, 2014

Miguel A. Del Toral and Andrea Porter – United States Environmental Protection Agency (U.S. EPA), Region 5, Chicago, IL

Michael R. Schock – U.S. EPA National Risk Management Research Laboratory (NRMRL), Cincinnati, OH

### **Acknowledgments**

The authors wish to express special thanks to Alan Stark and Andrea Putz at the City of Chicago Department of Water Management for the considerable time and effort put forth in providing information for this project, to the EPA and HUD volunteers who participated in this study, the team at the EPA Chicago Regional Laboratory for their work on the sample analyses, and Mostafa Noureldin (EPA) and Kevin Sui (Northwestern University) for their valuable assistance during this project.

Disclaimer: Any opinions expressed in this paper are those of the authors and do not necessarily reflect the official positions and policies of the EPA.

### Outline

- Background Information
  - Overview of LCR Sampling Requirements
  - Background on Study
  - Purpose of Study

#### Study Findings

- LCR sampling protocol significantly underestimated peak lead (Pb) levels and probable mass of released Pb
- Lead concentrations varied significantly within Lead Service Lines (LSLs).
- The majority of high lead results occurred at sites with LSL disturbances, with low water usage potentially playing a role.
- EPA and others' flushing recommendations can lead to higher lead exposure
- Lead levels were higher in warmer water temperature months
- Additional References and Resources

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# Background Information LCR Sampling Requirements

- Variability of Pb levels in drinking water
  - Pb can vary depending on site selection, sampling protocol, different corrosion mechanisms, homes with and without lead service lines, lead service line disturbances, water use, water chemistry/quality

EPA LCR (1991): "There is a high degree of variability in lead levels between and within systems as well as between individual taps. As a result, a sufficient number of samples is required in order to be confident that the measured lead levels are accurately assessed. This contrasts with other contaminants where variability is relatively small, and large numbers of samples are not required."

EPA LCR (1991): "EPA has sought to increase the degree to which the sampling will "catch" high levels in the system by requiring sampling at high-risk sites. The number of samples required by the final rule will, in EPAs judgement, sufficiently account for variability at taps while at the same time being reasonable for systems to implement."

### Background Information LCR Sampling Requirements

- LCR Site Selection and Sampling Protocol
  - Intent is to use worst-case conditions (site selection and sampling protocols) to find the highest lead
  - In 1991, the first-draw sample was intended to capture Pb from leaded solder, leaded brass and lead pipes/service lines
- · Worst-Case Sampling Conditions
  - If worst-case conditions were not used, the number of samples required to characterize lead levels would have to increase

EPA LCR (1991): "Targeting monitoring to worst-case conditions will help systems and States evaluate the reductions in contaminant levels achieved through treatment and determine when "optimal" treatment is being maintained to the degree most protective of public health."

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# Background Information LCR Sampling Requirements

LCR compliance is based on a '90th percentile value'.

No. of samples based on population

#### 90th Percentile - Math Refresher:

- For a set of values, the 90<sup>th</sup> percentile is the number where 90% of the values are lower
- Example: For a set of 10 values, order them from high to low; 90% percentile = the ninth value from the bottom.

18.3 µg/L 16.2 µg/L 14.4 µg/L 12.3 µg/L 12.1 µg/L 9.5 µg/L 9.2 µg/L 8.7 µg/L

 $3.4 \mu g/L$ 

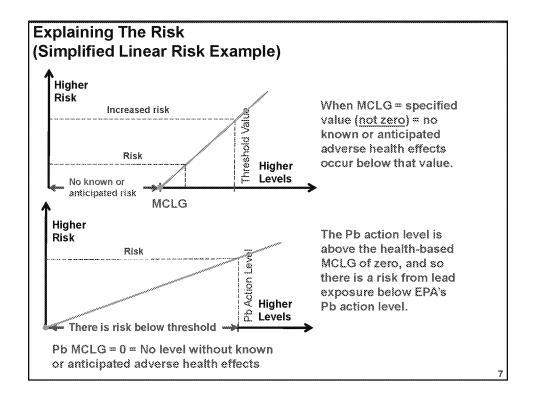
3.1 µg/L

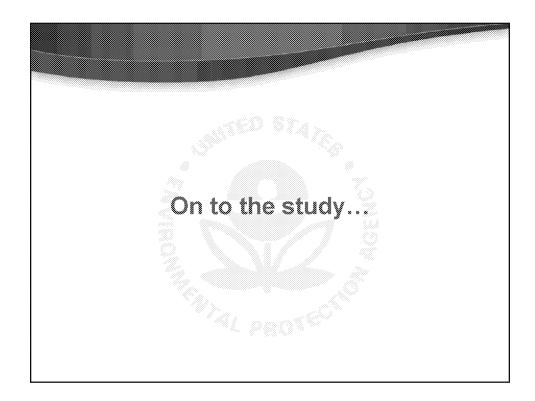
A PWS that exceeds the Pb AL based on their 90<sup>th</sup> percentile value must undertake the actions specified in the LCR.

# Explaining The Risk What is a Pb 'Action Level'?

- The action level is simply that
  - EPA's lead action level is a threshold value which requires public water systems to *take action* to reduce consumers lead exposure if lead levels exceed the lead 'action level' of 15 ppb.
    - Set at 15ug/L in 1991 based on EPA's understanding of the existing treatment capabilities and treatment costs at that time (i.e., achievable level)
- The Pb action level is NOT health-based
  - It's not a threshold level that separates safe and unsafe
     Pb levels
  - Based on EPA and CDC Risk Assessments:
    - · There is no safe level of exposure to lead.
    - Infants, children and pregnant women should avoid all exposure to lead.

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### Background Information Purpose of Study

- Purpose of Study
  - To evaluate the method used by public water systems to collect compliance samples for lead in drinking water.
- Although lead contributions from plumbing have changed, the LCR sampling protocol is prescriptive and has never been updated.
  - Leaded solder contribution has gone down in 20+ years since use was banned
  - Allowable lead in brass and other plumbing fixtures has been significantly reduced in Lead in Drinking Water Reduction Act, effective in Jan 2014.
  - Lead service lines will continue to be the largest source of lead in drinking water

# Background Information Study Roles and Responsibilities

#### EPA:

- · solicited volunteers
- analyzed samples
- · estimated LSL lengths



#### Volunteers:

- · collected samples
- · provided plumbing info
- info on LSL disturbances



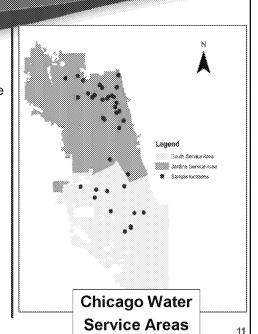
Chicago Department of Water Management:

- · water quality data
- Water main, service line materials data
- · water usage data
- work reports / data on disturbances to LSLs

...

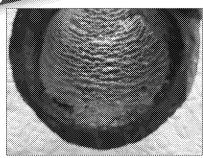
# Background Information Study Basics

- Homes were built between 1890 and 1960
  - 23 homes are served by Jardine plant
  - 9 homes are served by South plant
- Estimated lengths of LSLs ranged from 43 ft to 159 ft (13.1 to 48.5 m)
  - Information was unavailable for 2 sites
  - Some lead service lines extended beyond the front wall further into the home



# Background Information Chicago Department of Water Mgmt

- LCR Compliance Status?
  - ✓ Based on first-draw samples, per LCR requirement.
  - ✓ Consistently met LCR Pb action level since 1993.
- Corrosion control treatment?
   Blended phosphate addition for last
   19 years at two conventional treatment plants
- Chemical Additions? Chlorine; Aluminum Sulfate or Alum and Polymer; Activated Carbon; Fluoride





4.

## Background Information

Chicago Department of Water Mgmt

Chicago LCR Compliance Data

Water Quality (2011)					
ъ .	Ou	tlets	Distribution		
Parameter	Min	Max	Min	Max	
Temp (C)	4	24	5	23	
Turbidity (NTU)	0.1	0.2	0.1	0.4	
pН	7.5	7.8	7.7	7.8	
Cl <sub>2</sub> Residual (mg/L)	1.0	1.2	0.7	0.9	
Total Alkalinity (mg/L as CaCO <sub>3</sub> )	103	108	98	108	
Chloride (Cl, mg/L)	16	20	17	20	
Sulfate (mg/L)	29	31	29	30	
Ca (mg/L)	34	39	34	39	
PO <sub>4</sub> (mg/L)	0.4	0.6	0.5	0.5	
Total PO <sub>4</sub> (mg/L)	0.8	1.1	0.8	1.2	
Al (μg/L)	34	126	29	113	
Fe (µg/L)	<5	<5	<5	34	
Mn (μg/L)	<3	<3	<3	<3	

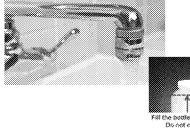
City of Chicago (1992 – 2010) 90 <sup>th</sup> Percentile Lead Values (µg/L)					
Monitoring Period End	No. of Samples	90th %ile Value			
12/31/2010	50	6			
12/31/2007	50	6			
12/31/2004	50	4			
12/31/2001	50	7			
12/31/1999	50	8			
12/31/1998	53	14			
12/31/1997	100	11			
6/30/1997	100	10			
6/30/1993	100	13			
12/31/1992	120	20			
6/30/1992	100	10			
	Monitoring Period End 12/31/2010 12/31/2007 12/31/2004 12/31/2001 12/31/1999 12/31/1998 12/31/1997 6/30/1997 6/30/1993 12/31/1992	Monitoring   No. of   Period End   Samples   12/31/2010   50   12/31/2004   50   12/31/2001   50   12/31/2001   50   12/31/1999   50   12/31/1998   53   12/31/1997   100   6/30/1997   100   6/30/1993   100   12/31/1992   120			

# Background Information Study Sampling

All samples → Volume = 1 liter; Stagnation time >= 6 hours

#### Three rounds of monitoring:

- 1) Mar/Apr 2011
  - √ first-draw
  - √ flushed: 45 sec
- 2) June 2011
  - √ 12 sequential
- Sept/Oct 2011
  - ✓ 11+ sequential
  - √ first-draw
  - ✓ flushed: 3, 5, 7 minute



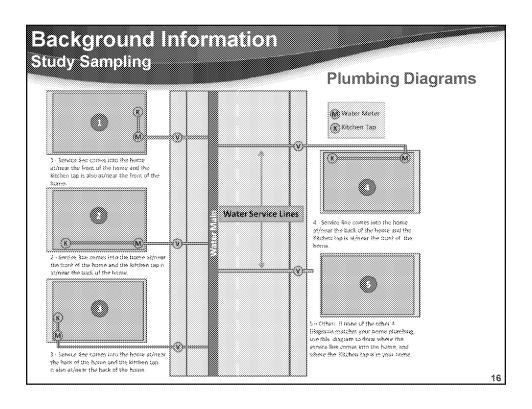


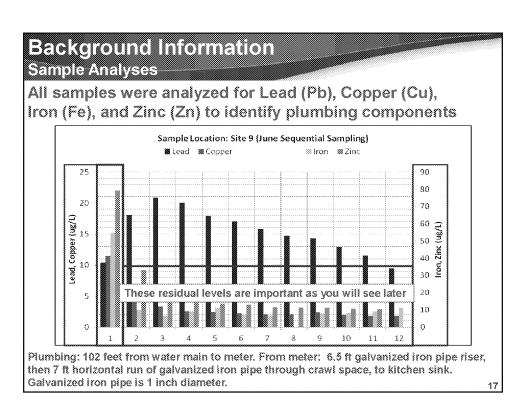
 "First-draw" included normal household use (NHU) or preflushing (PF) prior to a minimum 6 hour stagnation time

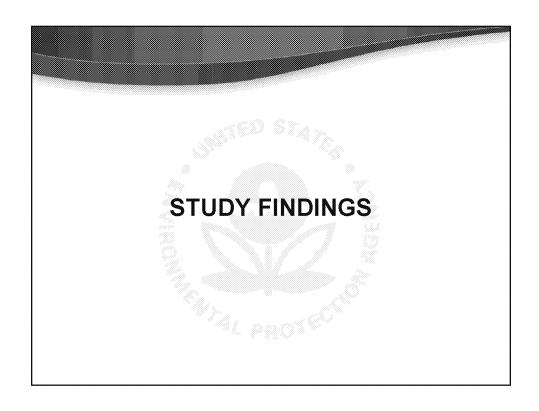
First-Draw :: 1st Sequential :: LCR-Type Compliance Samples

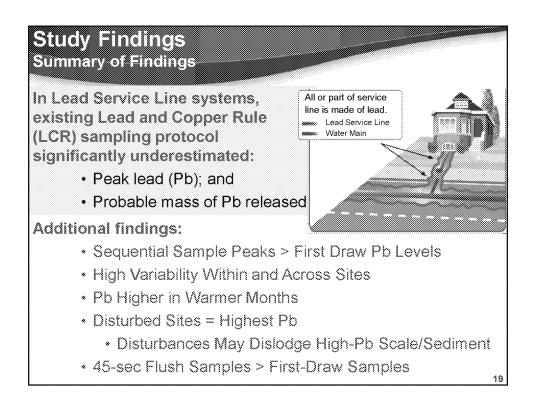
## Background Information Study Sampling

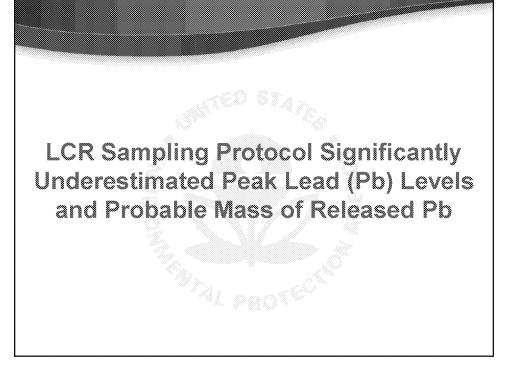
- First-draw samples
  - Pre-flushed (PF) First-Draw Samples
    - Volunteers were instructed to run the water for 5 minutes before beginning the minimum 6 hour stagnation period before sampling.
  - Normal Household Use (NHU) First-Draw Samples
    - Volunteers were instructed to use water as it is normally used in the household, but allow a minimum 6 hour stagnation period before sampling. Volunteers were not instructed to run the water for 5 minutes the night before.
- Flushed sample (45 second, 3 min, 5 min, 7 min, 10 min)
  - Run the water for the specified amount of time and then collect the sample.
- Stagnation times (all samples)
  - Most stagnation times were relatively consistent across most sites at between 6 and 8.5 hours
  - All but two sites had stagnation times ranging from 6 hours to 9 hours 10
     min

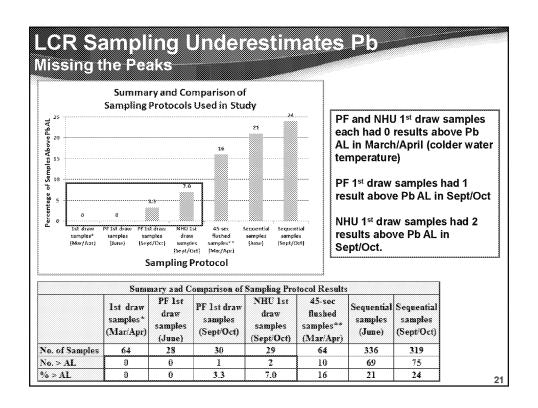


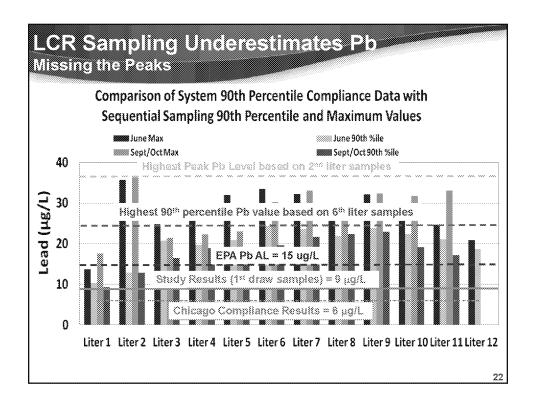


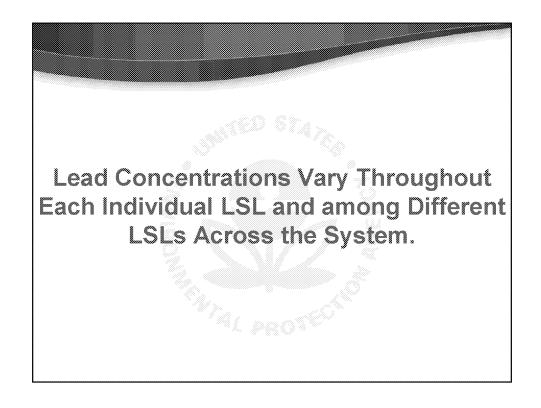


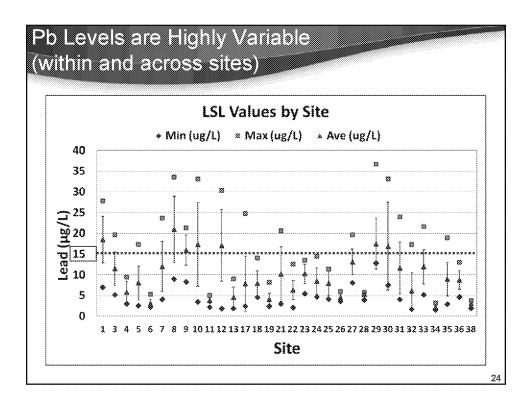








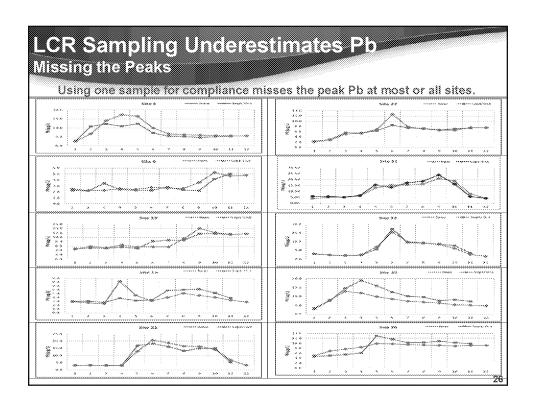




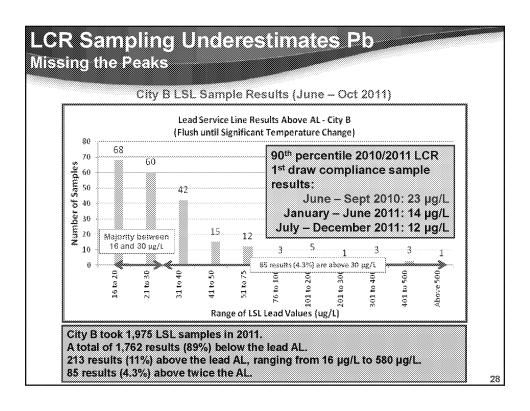
### LCR Sampling Underestimates Pb

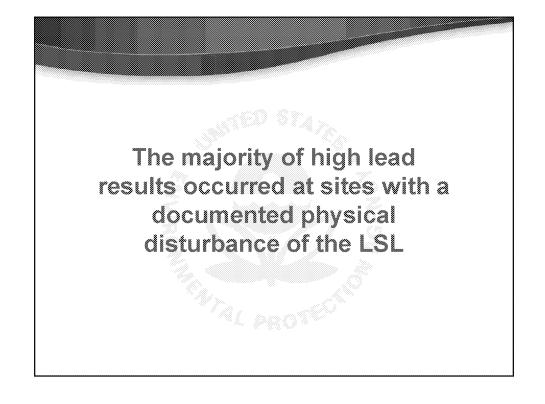
#### Missing the Feaks

- Why are Pb levels so variable?
  - Lead service lines vary in length
  - Length of internal plumbing before LSL varies significantly and every home's plumbing is different
    - · Some LSLs end just inside the front wall
    - · Some LSLs continue beyond the front wall
    - Kitchen tap locations vary home by home (front, middle, back of home, same side as meter/opposite side from meter)
  - Corrosion mechanisms can be different
    - · Uniform corrosion
    - · Galvanic corrosion
    - · Particulate Pb release / transport of Pb with Fe/Mn particles into homes
  - LSL disturbances can occur at different points in the LSL
    - · Water main repair or replacement or significant street excavation
    - · Service shut-off valve or leak repair or replacement
    - · Water meter or AMR installation or repair
  - Water use varies



				Jun	c (28 S	ltes)						
If this liter is used across all sites	1st liter	2nd liter	3rd liter	4th liter	5th liter	6th liter	7th liter	8th liter	9th liter	10th liter	11th liter	12th liter
No. of sites that miss peak lead value	28	27	26	25	26	22	25	28	24	24	28	26
Percent of sites that miss peak lead value	100%	96%	93%	89%	93%	79%	89%	100%	86%	86%	100%	93%
		55.	eptemi	κτ/ O	ctober	30 Site	:83					
If this liter is used across all sites	1st liter	2nd liter	3rd liter	4th liter	5th liter	6th liter	7th liter	8th liter	9th liter	10th liter	11th liter	
No. of sites that miss peak lead value	30	29	28	27	28	25	24	30	23	28	28	
Percent of sites that miss peak lead	100%	97%	93%	90%	93%	83%	80%	100%	77%	93%	93%	

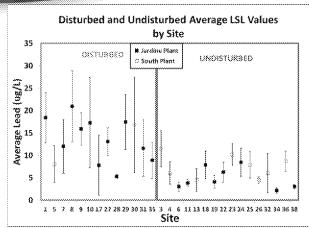




## Disturbed LSL Sites had Highest Pb What is a 'Disturbed LSL Site'?

#### **Disturbed LSL Sites**

- Street excavation in front of home (e.g., main replacement)
- External service shut-off valve repair/replacement
- Service line leak repair
- Meter installation or replacement
- Auto-meter-reader (AMR) installation



Indeterminate Sites	Total Samples Collected	No. Samples above Lead AL
12	27	17
21	27	7
33	27	6

Disturbed LSL Sites had Highest # of Disturbed Sites 13 36% **Total Samples Collected** 327 over 15 ug/L # Samples Above 15 ug/L 117 Disturbance → Scale has fallen off # of Undisturbed Sites 16 **Total Samples Collected** 2 % 372 (Undisturbed) over 15 ug/L # Samples above 15 ug/L 6 Lead service line disturbances were found to be a common factor for the majority of sites with high lead Disturbance minimized levels. It is also possible that low water usage may during pipe removal → Intact play a role in sites with the highest lead levels. scale



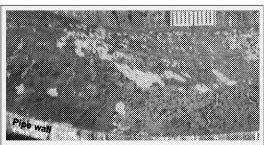
Overview

#### General Corrosion Control theory →

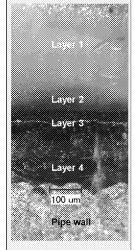
Add orthophosphate to form insoluble scales on the pipe wall and inhibit Pb release.

#### How to check?

Characterize corrosion scales on plumbing materials.



Whole Pb Service Line: Cut open to expose corrosion scales.



Magnified Scales View: Separated into layers by color and texture.

### Pipe Scale Analysis:

Results

	Layer	Αl	Ca	Fe	Р	Pb	Zn
	1	16	7	1.9	11	14	0
Pb Service Line	2	12	4	0.5	6	39	0
Average	3	4.8	1	0.4	2.1	62	0
	4	0.4	0	0.1	0.2	80	0
*Flements are exn	ressed	in w	eight	%			

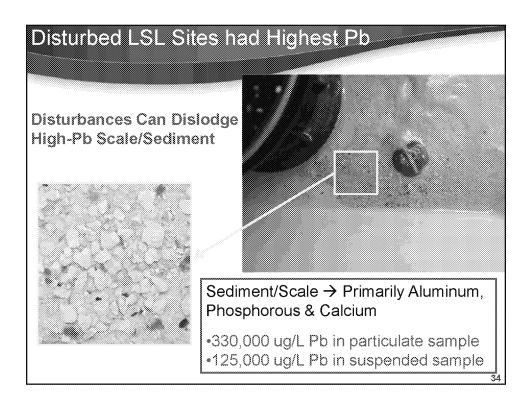
Elements are expressed in weight %.

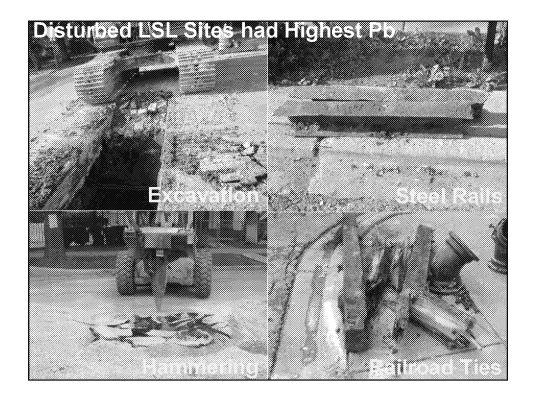
#### Conclusions

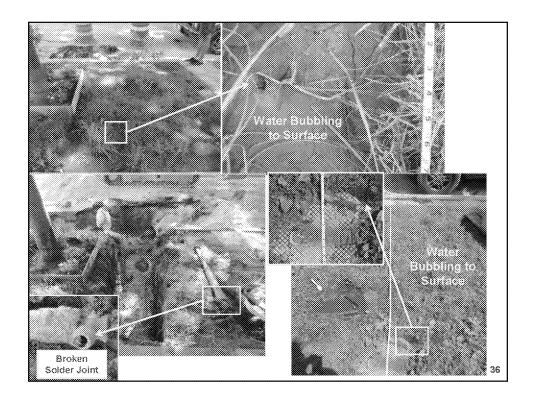
- · No insoluble Pb-phosphate found in any scale layer.
- Layer 1 → blanket-like layer with elevated Al, Ca, and P content.

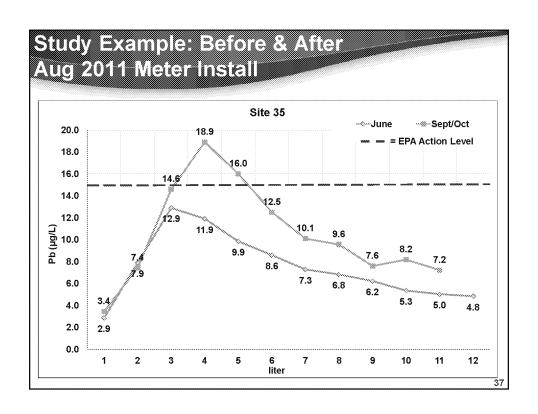
Inhibition of Pb release here does not follow general theory of insoluble scale. Instead, Pb release inhibited by amorphous diffusion barrier (blanket-like layer).

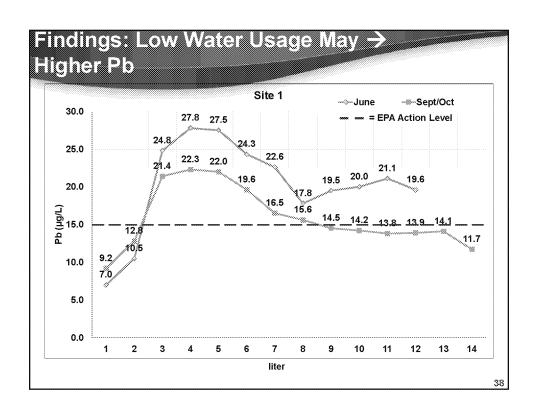
- Why? Composition of the Pb pipe barrier layer may be due to reaction of blended phosphate and Al carry-over from coagulation and natural hardness.
- How does this increase Pb release risk? Layer 1 is not well-adhered to pipe wall. Layer 1 easily sloughs off when disturbed. Dislodged scale releases particulate Pb. When Layer 1 is knocked off, exposes underlying layers with higher Pb content.



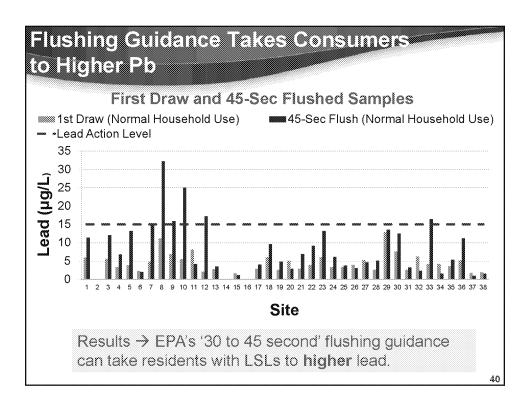












F	lushed Sa	ımple Su	mmary [	Γable (μ	g/L)
Site	NHU 45sec	PF 45sec	3min	5min	7min
01	11.3	11.9	6.48	6.56	6.97
03	12.0	6.71	3.78	2.93	
04	6.76	2.56			
05	13.2	14.1			
06	1.90	2.13			
07	15.3	24.9	5.49	5.46	5.32
08	32.2	28.0	8.25	5.54	5.71
09	15.9	17.7	14.3	7.23	
10	25.0	21.6	4.95	4.30	4.09
11	4.13	5.30	1.75	1.69	
12	17.2	5.45	1.78	1.45	1.33
13	3.50	2.94			
17	4.00	3.70	2.88	2.76	2.86
18	9.57	12.4	4.15	3.71	
19	4.69	8.27			
20	2.80	2.54			
21	6.87	13.8			
22	9.19	7.93			

Flushing for 3 to 5 minutes significantly reduced lead levels in homes that had the highest lead levels.

ŀ	lushed Sa	mple Sui	nmary T	able (μg	/L)
Site	NHU 45sec	PF 45sec	3min	5min	10min
23	13.1	11.5	5.64	4.54	
24	6.10	4.98	6.38	12.4	
25	3.75	ND			
26	3.02	3.45	5.06	3.23	
27	4.53	3.76	15.0	14.1	
28	4.99	4.70	4.82	3.26	
29	13.5	28.6	11.9	10.9	10.8
30	12.5	6.52	5.80	4.82	
31	3.16	12.3	3.78	3.76	
32	2.29	7.82			
33	16.4	14.0	4.40	4.06	
34	1.51	3.30	1.83	1.75	
35	5.28	10.5	5.53	4.03	
36	11.1	8.76	7.19	5.29	
38	1.60	2.30			

In most cases, flushing longer than 3 minutes did not appreciably reduce lead levels

There remains a 'baseline' level of lead in the drinking water which varies from site to site.

Red text indicates levels above the lead action level.

## Why Pre-flushing before collecting 1st draw samples resulted in the lowest lead levels.

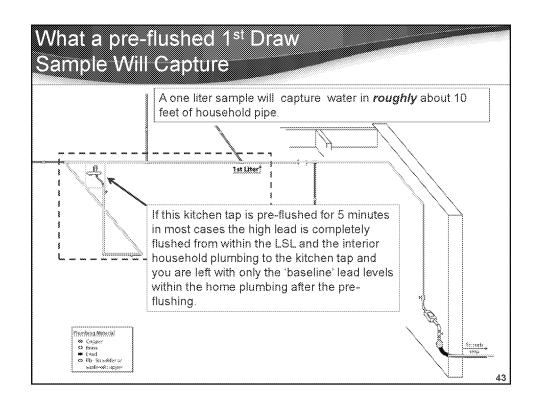
First-draw Sampling Variants

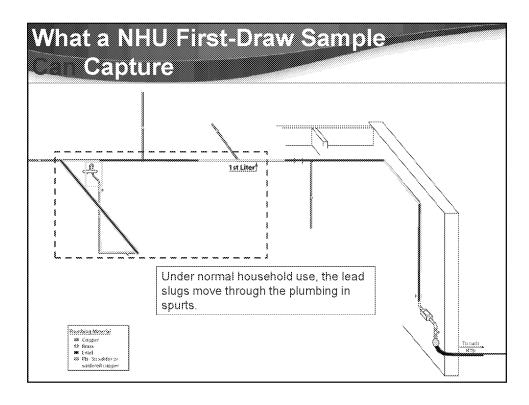
A NHU first-draw sample involves using the water as residents normally do before the 6 hour stagnation period and then not using water in the household for at least 6 hours until the first-draw sample is collected.

A pre-flushed (PF) first-draw sample involves running water for 5 minutes before the 6 hour stagnation period and then not using water in the household for at least 6 hours until the first-draw sample is collected.

A 5-minute flushed sample involves running the water for 5 minutes and then immediately collecting the sample (no stagnation period).

	First-Draw		Flushed
	Sept/Oct 2011	Sept/Oct 2011	Sept/Oct 2011
Site	First-Draw NHU	First-Draw PF	5min
Site 1	7.4	9.2	6.6
Site 3	10.0	8.3	2.9
Site 7	5.1	4.0	5.5
Site 8	17.5	9.2	5.5
Site 9	15.3	8.3	7.2
Site 10	5.0	3.5	4.3
Site 11	3.5	3.0	1.7
Site 12	2.3	5.4	1.5
Site 1?	2.7	2.7	2.8
Site 18	5.8	4.8	3.7
Site 23	9.2	7.0	4.5
Site 24	7.6	6.6	12.4
Site 26	4.5	4.9	3.2
Site 27	8.3	12.6	14.1
Site 28	4.3	3.9	3.3
Site 29	14.9	17.6	10.9
Site 30	8.4	7.9	4.8
Site 31	4.7	6.0	3.8
Site 33	5.6	5.5	4.1
Site 34	2.1	1.5	1.8
Site 35	5.0	3.4	4.0
Site 36	5.9	4.6	5.3
VE.	7.0	6.4	5.2





#### Pre-flushed vs. NHU first-draw samples

A one-liter sample will capture the lead in roughly ten feet of pipe from the kitchen tap (varies depending on inner pipe diameter and corrosion inside pipes).

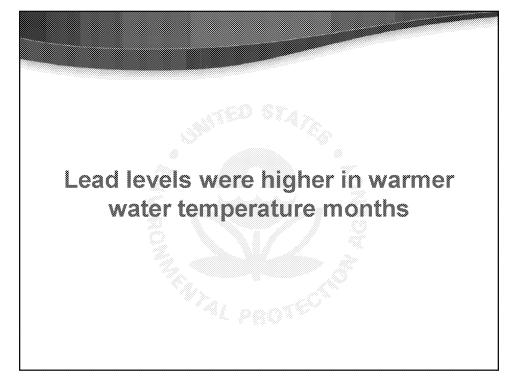
Site 8 – Galv. Fe and Cu pipe: LSL is approximately 54 ft from kitchen tap, so a PF 1st draw sample did not catch LSL water, but a NHU sample will sometimes catch it. Therefore, the NHU result can be significantly higher than the PF result.

Site 9 – Galv. Fe pipe: From Meter/LSL is 13.5 ft from kitchen tap so a PF 1st draw sample did not catch the LSL water, but a NHU sample will sometimes catch it. Therefore, the NHU result can be significantly higher than the PF result.

Site 29 – Short Cu pipe: The LSL comes in through the floor right under the kitchen sink so both the PF and the NHU 1st draw sample caught LSL water.

	First-Draw	ř.	Flushed
	Sept/Oct 2011	Sept/Oct 2011	Sept Oct 2011
Site	First DrawNHU	First Draw PF	5min
Site 1	7.4	9.2	6.6
Site 3	10.0	8.3	2.9
Site 7	5.1	4.0	5.5
Site 8	17,5	9.2	5.5
Site 9	15.3	8.3	7.2
Site 10	5.0	3.5	4.3
Site 11	3.5	3.0	1.7
Site 12	2.3	5.4	1.5
Site 17	2.7	2.7	2.8
Site 18	5.8	4.8	3.7
Site 23	9.2	7.0	4.5
Site 24	7.6	6.6	12.4
Site 26	4.5	4.9	3.2
Site 27	8.3	12.6	14.1
Site 28	4.3	3.9	3.3
Site 29	14.9	17.6	10.9
Site 30	8.4	7.9	4.8
Site 31	4.7	6.0	3.8
Site 33	5.6	5.5	4.1
Site 34	2.1	1.5	1.8
Site 35	5.0	3.4	4.0
Site 36	5.9	4.6	5.3
<b>XVE</b>	7.8	6.4	5.2

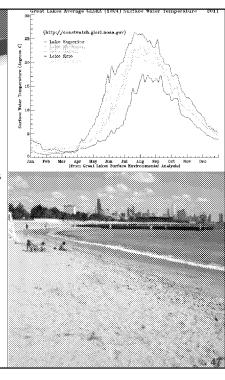
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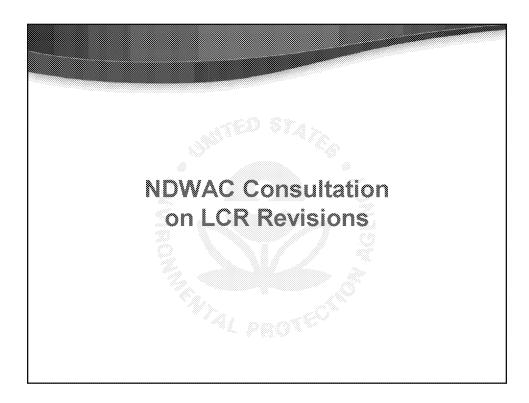


# Seasonal Variability Pb Higher in Warmer Months

- The LCR currently requires 'standard monitoring' to be conducted during two sixmonth rounds which each include a broad range of water temperatures
  - January through June
  - July through December
- Sampling conducted in colder water months (Mar/Apr) produced lower Pb levels than samples collected in the warmer water months (Sept/Oct)
  - Overall, 68% and 69% of NHU and PF first-draw samples, respectively, were higher in Sept/Oct than in Mar/Apr.

First-Draw Mar/Apr vs. Sept/Oct	Normal Household Use	Pre-Flush
Student's t-Test P-Value (two-tailed, paired)	0.03	0.04





# NDWAC Consultation on Potential LCR Revisions

- NDWAC White Paper on Potential LCR Revisions:
  - Sample Site Selection Criteria
  - Lead Sampling Protocol
  - Public Education for Copper
  - Measures to Ensure Optimal Corrosion Control Treatment
  - Lead Service Line Replacement

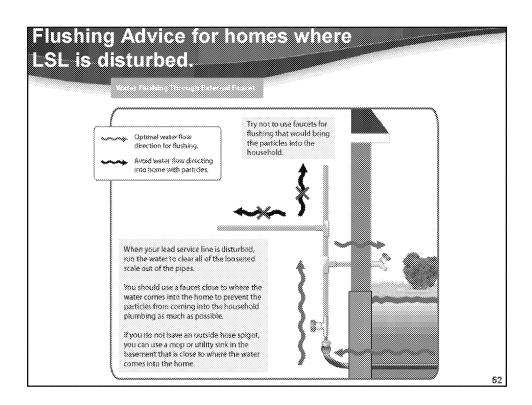
NDWAC Website: http://water.epa.gov/drink/ndwac

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### Take Home Messages

- The current LCR compliance sampling significantly underestimated lead levels
- Care should be taken when performing work to minimize the disturbance of LSLs
  - Provide flushing instructions when LSLs are disturbed (see next slide)
  - Flushing recommendations for homes with LSLs should be updated to avoid increasing consumers' lead exposure.
- Where feasible, removal of LSLs is the best permanent solution
  - AWWA/AMWA: "We support replacement of lead service lines that significantly contribute to high lead levels in the home."
  - LSLs can result in many unintended consequences for other treatment, operational and maintenance activities, as well as compliance complications.



### Take Home Messages

- PWSs CANNOT use alternative site selection criteria or LSL sampling for compliance right now
  - LCR site selection and sampling protocol is prescriptive, with no flexibility to change sampling protocol (static since 1991)
  - PWSs CAN use alternative site selection criteria and sampling protocols to help optimize corrosion control.
- Consult with State!
  - PWSs can incur violations if LCR sampling requirements are not followed for compliance samples.

#### Additional Information

#### For more information on Chicago Lead Sampling Study:

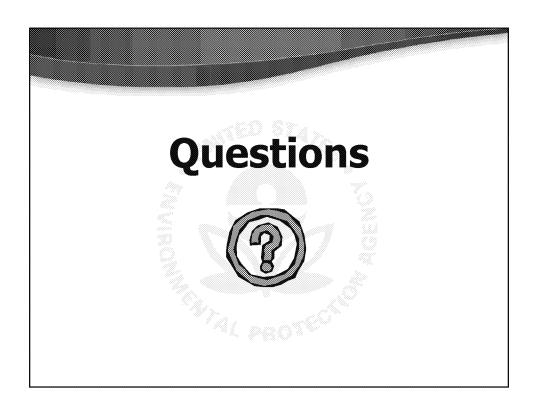
http://www.epa.gov/Region5/water/chicagoserviceline/index.html

- Chicago Lead in Drinking Water Study (download)
- · Advice for Residents
- How do I know if I have a LSL
- · What do LSLs look like
- · Cleaning aerators
- Flushing instructions
- · Collecting water samples

#### **Related Journal Article:**

Del Toral, M. A., Porter, A., & Schock, M. R. (2013). Detection and Evaluation of Lead Release from Service Lines: A Field Study. *Environmental Science and Technology*, 47(16), 9300-9307. doi:10.1021/es4003636

Miguel A. Del Toraldeltoral miguel@epa.gov312-886-5253Michael R. Schockschock michael@epa.gov513-569-7412Andrea Porterporter andrea@epa.gov312-886-4427



## Detection and Evaluation of Elevated Lead Release from Service Lines: A Field Study

ISAWWA February 3, 2014

Miguel A. Del Toral and Andrea Porter – United States Environmental Protection Agency (U.S. EPA), Region 5, Chicago, IL

Michael R. Schock – U.S. EPA National Risk Management Research Laboratory (NRMRL), Cincinnati, OH

## **Acknowledgments**

1

The authors wish to express special thanks to Alan Stark and Andrea Putz at the City of Chicago Department of Water Management for the considerable time and effort put forth in providing information for this project, to the EPA and HUD volunteers who participated in this study, the team at the EPA Chicago Regional Laboratory for their work on the sample analyses, and Mostafa Noureldin (EPA) and Kevin Sui (Northwestern University) for their valuable assistance during this project.

Disclaimer: Any opinions expressed in this paper are those of the authors and do not necessarily reflect the official positions and policies of the EPA.

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### Outline

- What we found about lead in drinking water
  - Potential for release of very high lead into drinking water
  - Underestimation of lead levels in drinking water
- Background Information
  - Lead and Copper Rule Main Components
  - Overview of LCR Sampling Requirements
  - Purpose of Study
  - Background on Study

2

### Outline (continued)

#### Study Findings

- LCR sampling protocol significantly underestimated peak lead (Pb) levels and probable mass of Pb released into the drinking water
- Lead concentrations varied significantly within the Lead Service Lines (LSLs )
- The majority of high lead results occurred at sites with LSL disturbances, with low water usage potentially playing a role.
- Existing flushing recommendations can lead to higher lead exposure
- Lead levels were higher in warmer water temperature months
- Update on Lead and Copper Rule Revisions

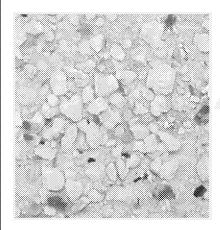
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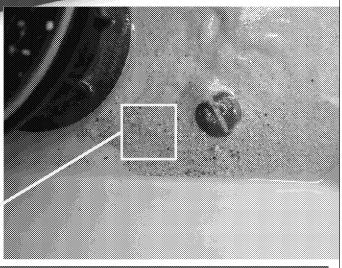


### Lead Service Line Disturbances

Very High Lead in Scale/Sediment

Disturbances Can Dislodge High-Pb Scale/Sediment





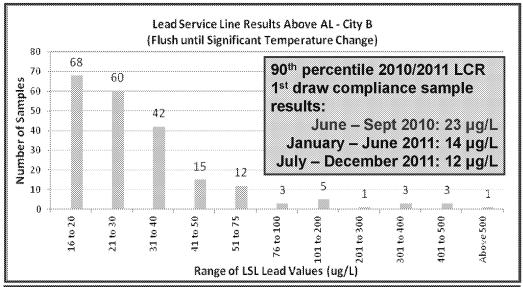
Sediment/Scale → Primarily Aluminum, Phosphorous & Calcium

•330,000 μg/L Pb in particulate sample •125,000 μg/L Pb in suspended sample

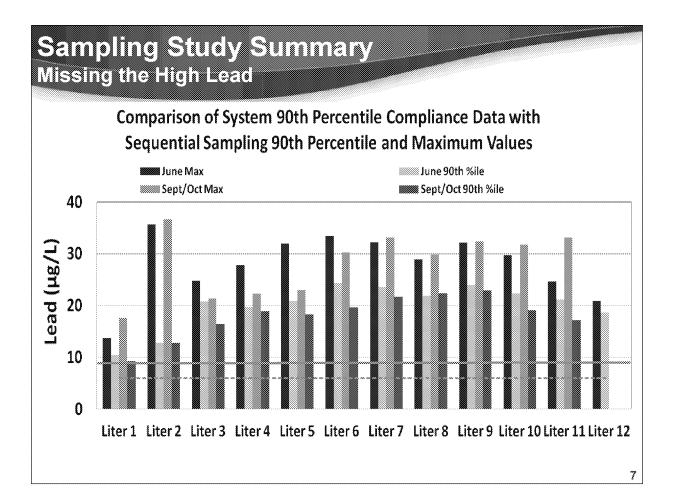
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# Measuring Lead Levels Missing the High Lead

City B LSL Sample Results (June - Oct 2011)



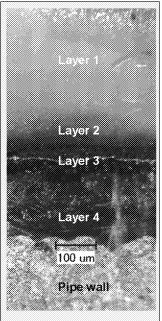
City B took 1,975 LSL samples in 2011. A total of 1,762 results (89%) below the lead AL. 213 results (11%) above the lead AL, ranging from 16  $\mu$ g/L to 580  $\mu$ g/L. 85 results (4.3%) above twice the AL.



## Pipe Scale Analysis Overview



**Whole Pb Service Line:** Cut open to expose corrosion scales.



Magnified Scales View: Separated into layers by color and texture.

-3

# Background Information Lead and Copper Rule (LCR)

- Lead and Copper Rule Major Components
  - All public water systems (PWSs) must optimize corrosion control to minimize lead/copper levels at consumers' taps
  - PWSs must sample for lead and copper at consumers taps
    - The intent is to collect lead/copper samples at highrisk homes, to capture worst-case lead and copper levels and systems that exceed EPA's 'action level' for lead and/or copper must undertake actions specified by the rule
  - Systems that exceed EPA's 'action level' for lead and/or copper in more than 10% of the samples collected must undertake actions specified by the rule.

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# Background Information Lead and Copper Rule (LCR)

- Lead and Copper Rule Major Components
  - For Lead AL exceedances, PWSs must:
    - Install corrosion control treatment, if they have not already done so
    - Provide public education material on lead to consumers
    - Increase monitoring if they are on a reduced monitoring frequency
  - If the PWS has already optimized their corrosion control treatment, the PWS must begin removing the portions of the lead service lines (LSLs) that they own, where results show the lead levels are above the lead AL.

# Background Information Variability of Lead Release

#### Variability of Pb levels in drinking water

EPA LCR (1991): "There is a high degree of variability in lead levels between and within systems as well as between individual taps. As a result, a sufficient number of samples is required in order to be confident that the measured lead levels are accurately assessed. This contrasts with other contaminants where variability is relatively small, and large numbers of samples are not required."

EPA LCR (1991): "EPA has sought to increase the degree to which the sampling will "catch" high levels in the system by requiring sampling at high-risk sites. The number of samples required by the final rule will, in EPAs judgement, sufficiently account for variability at taps while at the same time being reasonable for systems to implement."

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# Background Information Variability of Lead Release

- Many potential sources of lead in drinking water
  - Homes may or may not have lead service lines
  - Leaded-solder
  - Leaded-brass faucets, fixtures and plumbing components
- Lead dissolves from lead service lines into the water
  - LSLs vary considerably in length & water aggressiveness also varies
- Length of internal plumbing before LSL varies significantly and every home's plumbing is different
  - The distance from the home to the water main varies considerably
  - Some LSLs end just inside the front wall
  - Some LSLs continue beyond the front wall
  - Kitchen tap locations vary home by home (front, middle, back of home, same side as meter/opposite side from meter)

# Background Information Variability of Lead Release

- Corrosion mechanisms can be different
  - Uniform corrosion
  - Galvanic corrosion
  - Particulate Pb release / transport of Pb with Fe/Mn particles into homes
- LSL disturbances can occur at different points in the LSL
  - Water main repair or replacement or significant street excavation
  - Service shut-off valve or leak repair or replacement
  - Water meter or AMR installation or repair
- Changes in water chemistry or treatment can significantly affect lead levels
  - Many public water systems have experienced significant increases in lead levels as a result of changes in water quality and other treatment or operational changes, resulting in high levels for significant periods of time, in many cases for years.
- Water use varies

### Background Information LCR Sampling Requirements

- LCR Site Selection and Sampling Protocol
  - Intent is to use worst-case conditions (site selection and sampling protocols) to find the highest lead
  - In 1991, the first-draw sample was intended to capture Pb from leaded solder, leaded brass and lead pipes/service lines
- Worst-Case Sampling Conditions
  - If worst-case conditions were not used, the number of samples required to characterize lead levels would have to increase

EPA LCR (1991): "Targeting monitoring to worst-case conditions will help systems and States evaluate the reductions in contaminant levels achieved through treatment and determine when "optimal" treatment is being maintained to the degree most protective of public health."

### Background Information

#### LCR Sampling Requirements

LCR compliance monitoring is based on a '90th percentile value'.

### No. of samples based on population

#### 90th Percentile - Refresher:

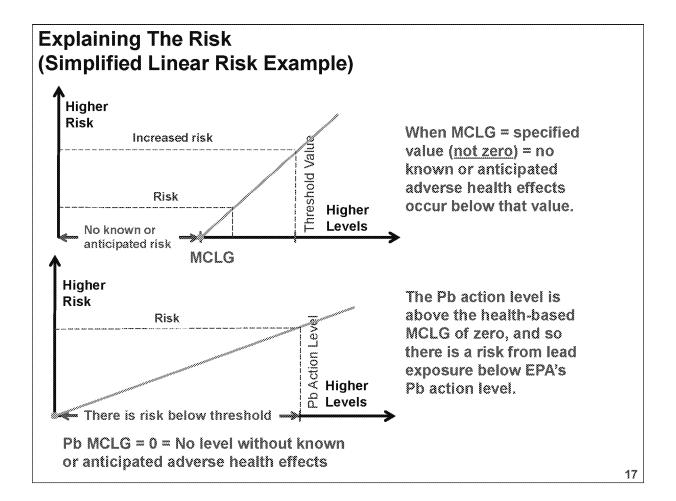
- For a set of values, the 90<sup>th</sup> percentile is the number where 90% of the values are lower.
- Example: For a set of 10 values, order them from high to low; 90% percentile = 10 x 0.9 = 9 (ninth value from the bottom).

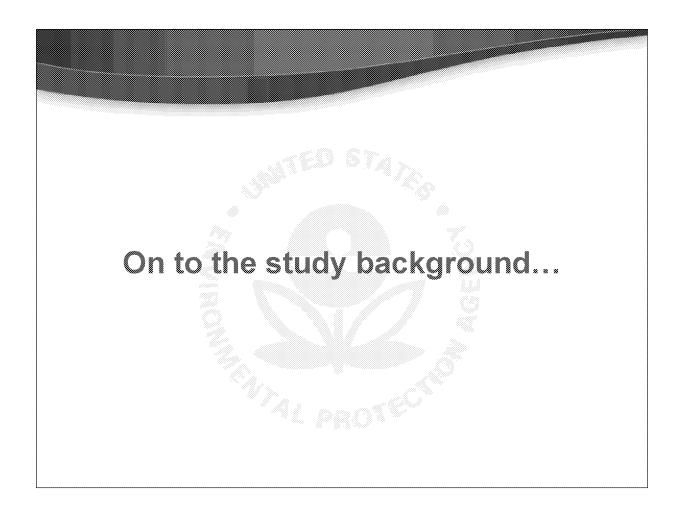
18.3 µg/L	<u>10</u>
16.2 µg/L	9
14.4 µg/L	<u>8</u>
12.3 µg/L	7
12.1 µg/L	<u>6</u>
9.5 µg/L	<u>5</u>
9.2 µg/L	4
8.7 µg/L	<u>3</u>
3.4 µg/L	2
3.1 µg/L	1

A PWS that exceeds the Pb AL based on their 90<sup>th</sup> percentile value must undertake the actions specified in the LCR.

### Background Information What is a Pb 'Action Level'?

- The action level is simply that
  - EPA's lead action level is a threshold value which requires public water systems to *take action* to reduce consumers lead exposure if lead levels exceed the lead 'action level' of 15 ppb.
    - Set at 15ug/L in 1991 based on EPA's understanding of the existing treatment capabilities and treatment costs at that time (i.e., achievable level)
- The Pb action level is NOT health-based
  - It's not a threshold level that separates safe and unsafe
     Pb levels
  - EPA and CDC Risk Assessments:
    - · There is no safe level of exposure to lead.
    - Infants, children and pregnant women should avoid all exposure to lead.





# Background Information Purpose of Study

- Purpose of Study
  - To evaluate the method used by public water systems to collect compliance samples for lead in drinking water.
- Although lead contributions from plumbing have changed, the LCR sampling protocol is prescriptive and has never been updated.
  - Leaded solder contribution has gone down in 20+ years since use was banned
  - Allowable lead in brass and other plumbing fixtures has been significantly reduced in Lead in Drinking Water Reduction Act, effective in Jan 2014.
  - Lead service lines will continue to be the largest source of lead in drinking water

# Background Information Study Roles and Responsibilities

#### EPA:

- · solicited volunteers
- analyzed samples
- estimated LSL lengths





- Volunteers:
- · collected samples
- provided plumbing info
- · info on LSL disturbances

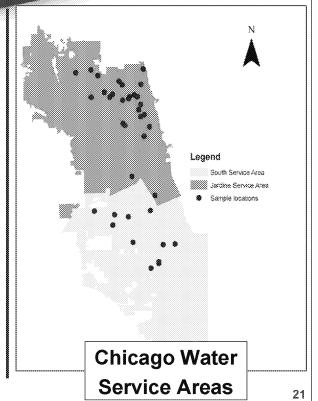
- water quality data
- Water main, service line materials data
- · water usage data
- work reports / data on disturbances to LSLs

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# Background Information Study Basics

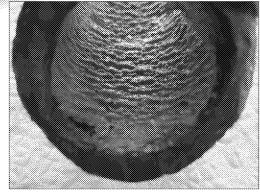
- Homes were built between 1890 and 1960
  - 23 homes are served by Jardine plant
  - 9 homes are served by South plant
- Estimated lengths of LSLs ranged from 43 ft to 159 ft (13.1 to 48.5 m)
  - Information was unavailable for 2 sites
  - Some lead service lines extended beyond the front wall further into the home



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## Background Information Chicago Department of Water Mgmt.

- LCR Compliance Status?
  - ✓ Based on first-draw samples, per LCR requirement.
  - ✓ Consistently met LCR Pb action level since 1993.
- Corrosion control treatment?
   Blended phosphate addition for last
   19 years at two conventional
   treatment plants
- Chemical Additions? Chlorine; Aluminum Sulfate or Alum and Polymer; Activated Carbon; Fluoride





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# Background Information Chicago Department of Water Mgmt

Chicago LCR Compliance Data

Danamatan	Out	tlets	Distri	bution
Parameter	Min	Max	Min	Max
Temp (C)	4	24	5	23
Turbidity (NTU)	0.1	0.2	0.1	0.4
рH	7.5	7.8	7.7	7.8
Cl <sub>2</sub> Residual (mg/L)	1.0	1.2	0.7	0.9
Total Alkalinity (mg/L as CaCO <sub>3</sub> )	103	108	98	108
Chloride (Cl, mg/L)	16	20	17	20
Sulfate (mg/L)	29	31	29	30
Ca (mg/L)	34	39	34	39
PO <sub>4</sub> (mg/L)	0.4	0.6	0.5	0.5
Total PO <sub>4</sub> (mg/L)	0.8	1.1	0.8	1.2
Al (μg/L)	34	126	29	113
Fe (µg/L)	<5	<5	<5	34
Mn (μg/L)	<3	<3	<3	<3

City of Chicago (1992 – 2010) 90 <sup>th</sup> Percentile Lead Values (µg/L)						
Monitoring Period Begin	Monitoring Period End	No. of Samples	90th %ile Value			
1/1/2008	12/31/2010	50	6			
1/1/2005	12/31/2007	50	6			
1/1/2002	12/31/2004	50	4			
1/1/1999	12/31/2001	50	7			
1/1/1999	12/31/1999	50	8			
1/1/1998	12/31/1998	53	14			
7/1/1997	12/31/1997	100	11			
1/1/1997	6/30/1997	100	10			
1/1/1993	6/30/1993	100	13			
7/1/1992	12/31/1992	120	20			
1/1/1992	6/30/1992	100	10 23			

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### Background Information Study Sampling

#### All samples → Volume = 1 liter; Stagnation time >= 6 hours

#### Three rounds of monitoring:

- 1) Mar/Apr 2011
  - √ first-draw
  - √ flushed: 45 sec
- 2) June 2011
  - √ 12 sequential
- 3) Sept/Oct 2011
  - √ 11+ sequential
  - √ first-draw
  - ✓ flushed: 3, 5, 7 minute





ill the bottle up to here Do not overfill



"First-draw" included normal household use (NHU) or preflushing (PF) prior to a minimum 6 hour stagnation time

First-Draw :: 1st Sequential :: LCR-Type Compliance Samples

# Background Information Study Sampling

- First-draw samples
  - Pre-flushed (PF) First-Draw Samples
    - Volunteers were instructed to run the water for 5 minutes before beginning the minimum 6 hour stagnation period before sampling.
  - Normal Household Use (NHU) First-Draw Samples
    - Volunteers were instructed to use water as it is normally used in the household, but allow a minimum 6 hour stagnation period before sampling. Volunteers were not instructed to run the water for 5 minutes the night before.
- Flushed samples
  - 45 second
    - Run the water for 45 seconds after a 1<sup>st</sup> draw sample and then collect the 45 second flushed sample.
  - 3 min, 5 min, 7 min, 10 min
  - Run the water for 3 minutes, collect the 3-min flushed sample, let the water run for two more minutes, collect the 5-min flushed sample, etc.

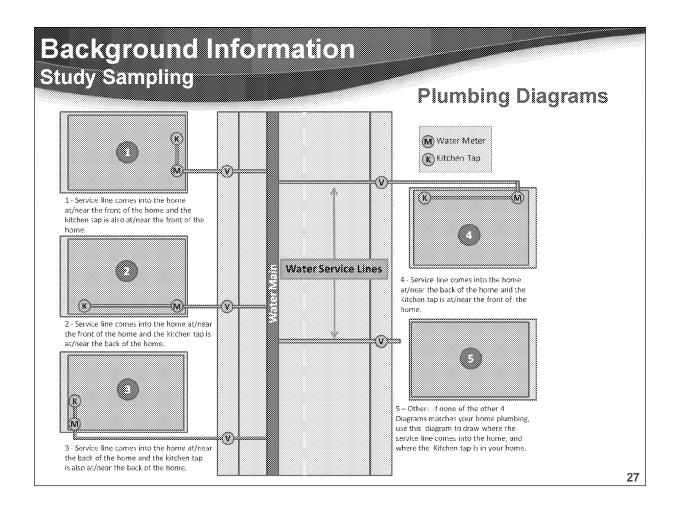
# Background Information Study Sampling

#### Sequential Samples

- Volunteers were instructed to run the water for 5 minutes before beginning the minimum 6 hour stagnation period to clear the high lead from the plumbing and then not to use water in the home until samples are collected.
- Following the stagnation period, volunteers collected samples one after the other without turning off the water.

#### Stagnation times (all samples)

- Most stagnation times were relatively consistent across most sites at between 6 and 8.5 hours
- All but two sites had stagnation times ranging from 6 hours to 9 hours 10 min

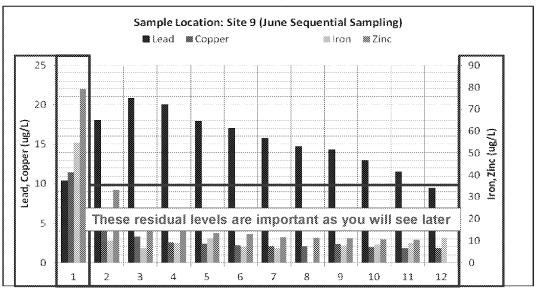


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### **Background Information**

Sample Analyses

All samples were analyzed for Lead (Pb), Copper (Cu), Iron (Fe), and Zinc (Zn) to identify plumbing components

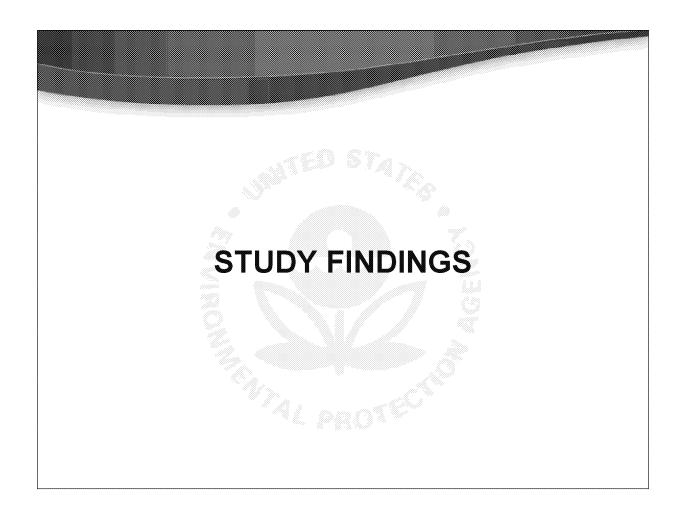


Plumbing: 102 feet from water main to meter. From meter: 6.5 ft galvanized iron pipe riser, then 7 ft horizontal run of galvanized iron pipe through crawl space, to kitchen sink. Galvanized iron pipe is 1 inch diameter.

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### Study Findings Summary of Findings

In Lead Service Line systems, existing Lead and Copper Rule (LCR) sampling protocol significantly underestimated:

- · Peak lead (Pb); and
- · Probable mass of Pb released

### Additional findings:

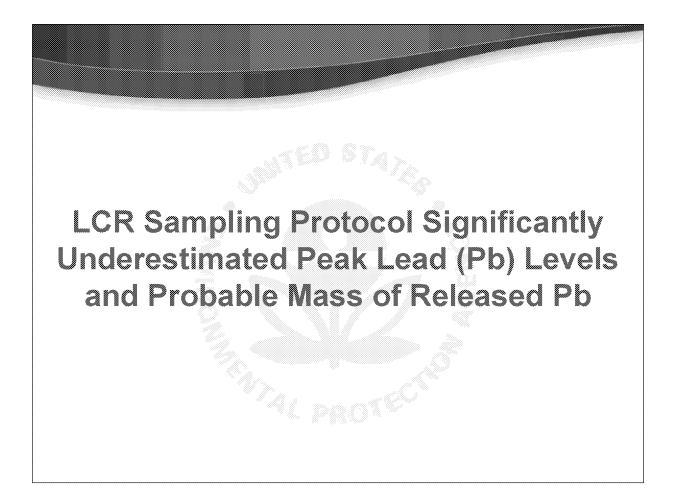
- Sequential Sample Peaks > First Draw Pb Levels
- High Variability Within and Across Sites
- Disturbed Sites = Highest Pb
  - Disturbances May Dislodge High-Pb Scale/Sediment

All or part of service line is made of lead.

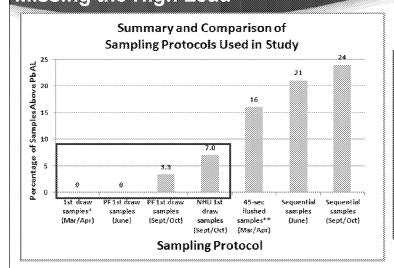
Water Main

Lead Service Line

- 45-sec Flush Samples > First-Draw Samples
- Pb Higher in Warmer Months



# LCR Sampling Underestimated Pb Missing the High Lead

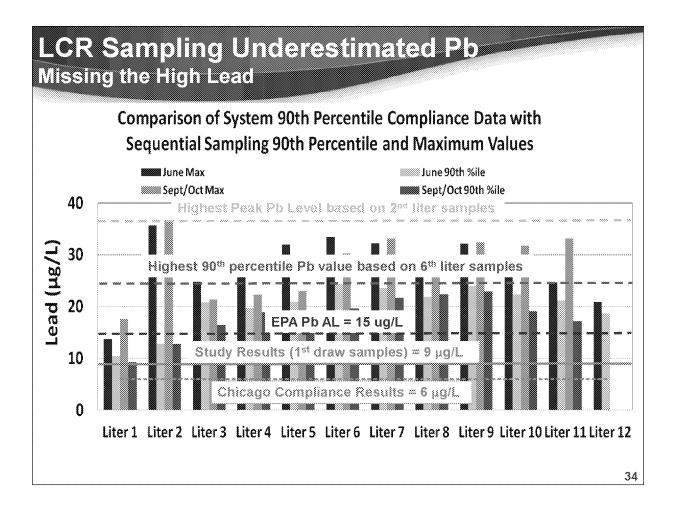


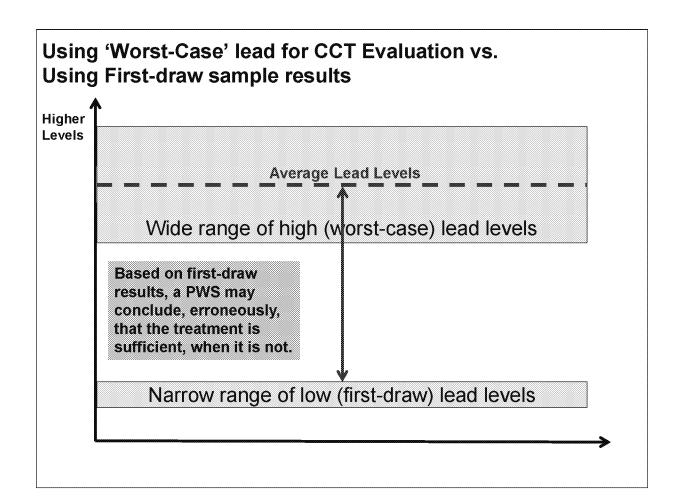
PF and NHU 1<sup>st</sup> draw samples each had 0 results above Pb AL in March/April (colder water temperature)

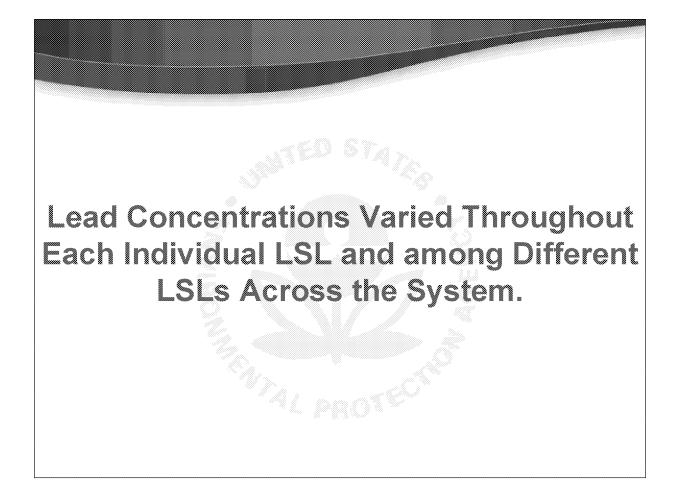
PF 1<sup>st</sup> draw samples had 1 result above Pb AL in Sept/Oct

NHU 1<sup>st</sup> draw samples had 2 results above Pb AL in Sept/Oct.

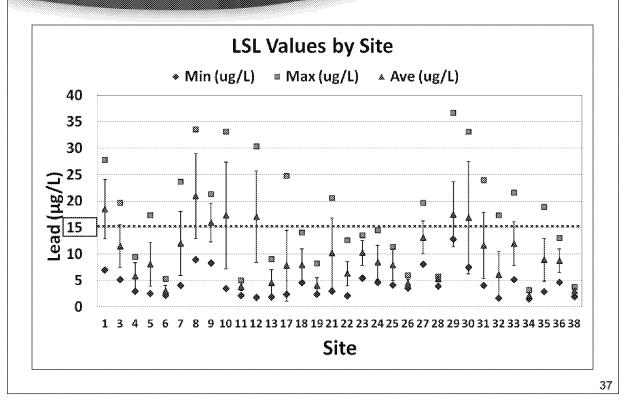
	Sumi	nary and C	omparison of	Sampling Pro	tocol Results		
	lst draw samples* (Mar/Apr)	PF 1st draw samples (June)	PF 1st draw samples (Sept/Oct)	NHU 1st draw samples (Sept/Oct)	45-sec flushed samples** (Mar/Apr)	Sequential samples (June)	Sequential samples (Sept/Oct)
No. of Samples	64	28	30	29	64	336	319
No. > AL	0	0	1	2	10	69	75
% > AL	0	0	3.3	7.0	16	21	24

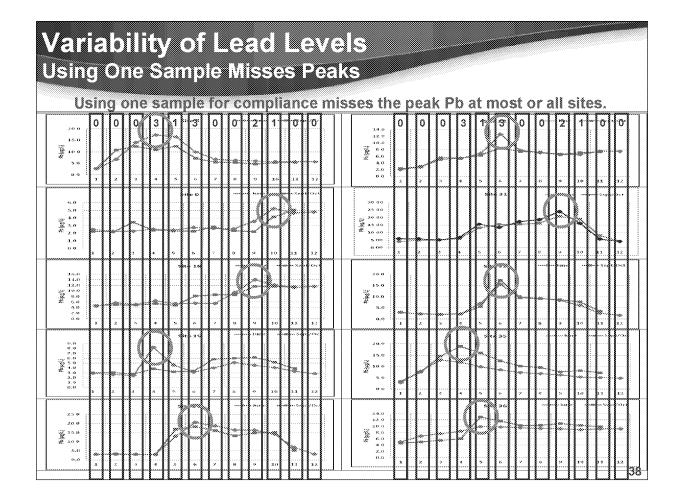






# Variability of Lead Levels Variable Within and Across Sites





# Variability of Lead Levels Using One Sample Misses Peaks

Using one sample misses peak Pb at most sites

				Jun	e (28 S	ites)						
If this liter is used across all sites	1st liter	2nd liter	3rd liter	4th liter	5th liter	6th liter	7th liter	8th liter	9th liter	10th liter	11th liter	12th liter
No. of sites that miss peak lead value	28	27	26	25	26	22	25	28	24	24	28	26
Percent of sites that miss peak lead value	100%	96%	93%	89%	93%	79%	89%	100%	86%	86%	100%	93%

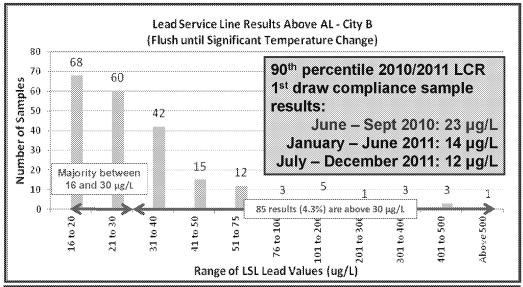
		S	eptemb	er/O	ctober	(30 Site	38)				
If this liter is used across all sites	1st liter	2nd liter	3rd liter	4th liter	5th liter	6th liter	7th liter	8th liter	9th liter	10th liter	11th liter
No. of sites that miss peak lead value	30	29	28	27	28	25	24	30	23	28	28
Percent of sites that miss peak lead value	100%	97%	93%	90%	93%	83%	80%	100%	77%	93%	93%

The 1st liter is currently used for LCR compliance sampling (missed the peak lead 100% of the time).

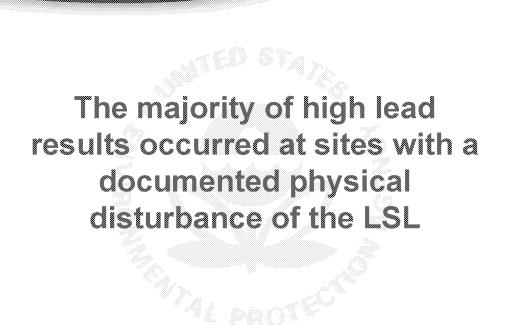
Using a specified single liter to collect compliance samples would miss the peak lead values at between 77% and 100% of the sites.

## Variability of Lead Levels Missing the High Lead

#### City B LSL Sample Results (June - Oct 2011)



City B took 1,975 LSL samples in 2011. A total of 1,762 results (89%) below the lead AL. 213 results (11%) above the lead AL, ranging from 16  $\mu$ g/L to 580  $\mu$ g/L. 85 results (4.3%) above twice the AL.

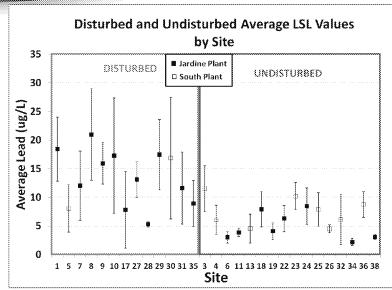


### Disturbed LSL Sites had Highest Pb

What is a 'Disturbed LSL Site'?

#### Disturbed LSL Sites

- Street excavation in front of home (e.g., main replacement)
- External service shut-off valve repair/replacement
- Service line leak repair
- Meter installation or replacement
- Auto-meter-reader (AMR) installation



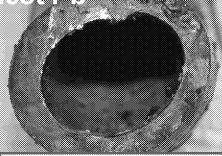
Indeterminate Sites	Total Samples Collected	No. Samples above Lead AL		
12	27	17		
21	27	7		
33	27	6		

### Disturbed LSL Sites had Highest Pb

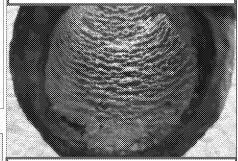
Physical Disturbances

# of Disturbed Sites	13	
Total Samples Collected	327	36% over 15 ug/L
# Samples Above 15 ug/L	117	
# of Undisturbed Sites	16	
Total Samples Collected (Undisturbed)	372	2 % over 15 ug/L
# Samples above 15 ug/L	6	

Lead service line disturbances were found to be a common factor for the majority of sites with high lead levels. It is also possible that low water usage may play a role in sites with the highest lead levels.



Disturbance → Scale has fallen off



Disturbance minimized during pipe removal → Intact scale

### Disturbed LSL Sites had Highest Pb.

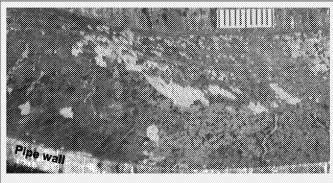
Pipe Scale Analysis Overview

#### General Corrosion Control theory →

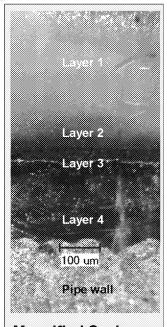
Add orthophosphate to form **insoluble** scales on the pipe wall and inhibit Pb release.

#### How to check?

Characterize corrosion scales on plumbing materials.



Whole Pb Service Line: Cut open to expose corrosion scales.



Magnified Scales View: Separated into layers by color and texture.